JUN 25 1926

THE ILLUMINATING ENGINEER

LIGHT
LAMPS
FITTINGS
AND
ILLUMINATION

THE JOURNAL OF
GOOD LIGHTING

. OIL .
GAS
ELECTRICITY
ACETYLENE
PETROL-AIR
GAS
ETC.

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by
LEON GASTER

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Special Features:

A Survey of the Lighting of 800 Retail Shops—Requirements for Office Lighting—Lectures on Illuminating Engineering—Recommendations on Industrial Lighting—The Life of Electric Lamps—Exterior Lighting with Gas—News from Abroad—Reviews of Books, etc.

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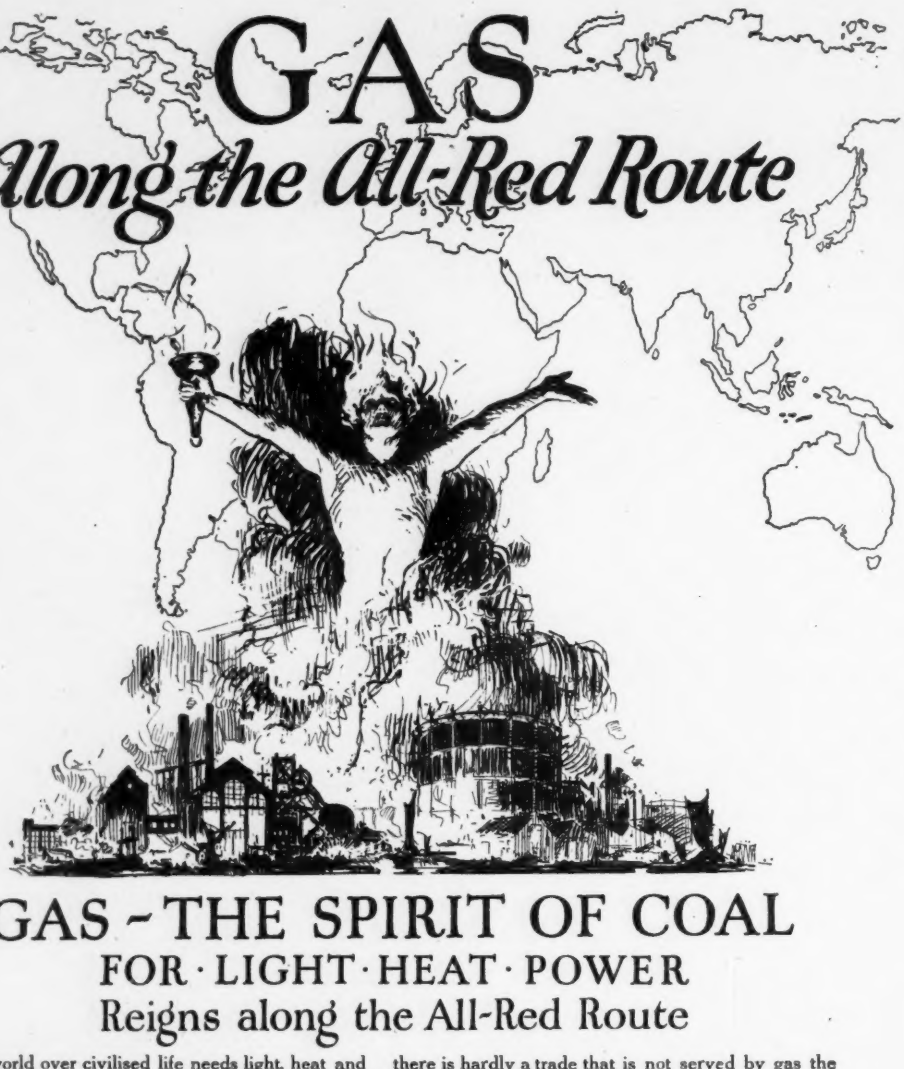
GAS
Along the All-Red Route



GAS - THE SPIRIT OF COAL
FOR · LIGHT · HEAT · POWER
Reigns along the All-Red Route

All the world over civilised life needs light, heat and power—fuel for its industries and homes. The gas industry at Wembley occupies the largest space in the centre of the Palace of Industry, because it provides for these fundamental needs. The Gas Exhibit shows gas as the enemy of waste, whether of human energy or of material resources such as coal. It shows the reasons why gas is triumphantly extending its services to the Empire all along the All-Red Route, from Manchester to Melbourne and Vancouver to Bombay.

Women visiting the Exhibit see the gas industry placing comfort, health and leisure—escape from drudgery, fatigue and strain—even within the reach of poorer pockets. They see how gas provides for heating, cooking and water-heating an almost automatic service. They see, what is shown again in the Palace of Housing, the infinite attractions of an all-gas house—an Ideal Home at last made real.

Manufacturers find the gas industry offering the most reliable, controllable, clean and efficient fuel—the key to improving output in quality and in quantity both at once. For light, for power, and, above all, for heat, there is hardly a trade that is not served by gas the Empire over. The Engineering, Motor, Shipbuilding, Textile, Leather, Pottery, and indeed nearly all great industries are shown in the Exhibit to profit by the use of gaseous fuel.

Workers in industry can learn, what many know already, the immense improvements that are wrought in factory conditions by the elimination of the hot and heavy labour of handling solid fuel, of stoking and of clearing ashes. They see and appreciate the benefits of clean surroundings which everywhere attend the use of gas.

All men and women have brought home to them the fact that the extended use of gas, whether in industry or the home, means an abatement of the coal-smoke curse and the blessed admission of sunshine to their lives. They see the proof that gas has made possible at last the achievement of the ideal smokeless city.

All these and many other things are illustrated by "Living Tableaux," cookery demonstrations with Empire food products, moving machinery or daylight cinema in the British Empire Gas Exhibit, Wembley, 1925.

THE BRITISH EMPIRE GAS EXHIBIT
(In the centre of the Palace of Industry)
AT WEMBLEY

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The
Gas Light and Coke Company
Horseferry Road
Westminster, S.W. 1

Be sure to visit the Gas Exhibit, and when home again let us know how we can help you.

See Page III of Cover

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A Survey of Lighting in 800 Retail Shops

THE paper read on the above subject at the last meeting of the Illuminating Engineering Society by Messrs. W. J. Jones and H. Lingard contained a very comprehensive series of data which need careful analysis and consideration before definite conclusions can be drawn. The discussion will be reproduced in our next issue. Meantime we wish to compliment the authors on a useful piece of work, and to express our appreciation of the hospitality of the E.L.M.A. Lighting Service Bureau in arranging for the meeting to be held in their hall, and providing facilities for an interesting display of shop-lighting appliances.

We have frequently pointed out the need for statistical data on various fields of lighting, and this is, we believe, the first attempt in this country to gather statistics on shop lighting on a comprehensive plan. It is natural, therefore, that the data should furnish material for discussion, and that some of the methods adopted should be the subject of comment. Broadly speaking, the results show that attempts to induce shopkeepers to adopt modern efficient illuminants have been fairly successful. It is significant, for example, that 81·5 per cent. of the lamps used in these shops should be of the gasfilled type, and that the 100-watt type should be found to predominate. But it may also be concluded—what is indeed common knowledge—that there is room for educational effort in order to ensure these lamps being more wisely used. Glare in retail shops is only too manifest, and, as the authors point out, this serves as a very bad object lesson to the rest of the community.

So far we seem to be on fairly safe ground. But when we come to the basis on which shops are ranked as being poorly, well, fairly or excellently lighted there seems ground for caution. One of the methods adopted is to judge the shop windows on the basis of watts consumed per foot of run. This is rather an indication which shops are the best customers in respect of generosity in the use of lamps, fittings, and electrical energy—doubtless an important consideration to the lighting industry but in itself taking no consideration of how this energy is applied. From the illuminating engineering standpoint the illumination in foot-candles provided over the whole window area would be a better indication. But even here it is necessary to remember that the amount of illumination needed may depend on the style of the window, the nature of the display, the special requirements of certain industries, and the vicinity of the shops, e.g., whether in a main street where bright lighting is general, or in a side street where the surroundings are darker. Hence, without going more fully into the circumstances, we should hesitate to condemn any particular class of shop because the consumption in watts per foot run appears low. The skill of the illuminating engineer is exercised in making the best use of the energy at his command. Thus in the competitions organized by the Illuminating Engineering Society in the United States (and doubtless also in the contest initiated by the E.L.M.A. and mentioned on page 134 in this issue), we find the same window lighted with different forms of units and varying consumption of energy; yet all the installations may have points in their favour, and the best lighted window is not necessarily that requiring the biggest supply of energy.

Certain types of shops appear to trespass in the use of bare lamps. The exhibit of bare lamps or unsatisfactory equipment in a window—even when there may be some explanation in the method of dressing or the requirements of the trade—can never be defended. But a classification in terms of "top reflectors" is not in itself entirely adequate. So much depends on the choice of reflector and its position relative to the goods. And before seeing any particular installation one would hesitate to say that such a general classification can be ranked as either good or bad.

Further, it must be recognized that the number of shops dealt with in the paper—even though obviously requiring a considerable amount of work—forms but a very small proportion, perhaps not more than 1/1000th of the total number of shops in this country. This alone, without further details, would incline one to accept the results rather as an indication than as a basis for rigid conclusions.

After raising these points we should like to add that, in spite of obvious limitations, we regard this survey as a most important piece of work. We should like to see this preliminary investigation followed up by more detailed analysis of certain classes of shops, classified by district, so that we can consider each locality in turn. The requirements of each industry being carefully studied, we should then be able not only to form a more certain estimate of existing defects, but to understand why these bad practices occur. We may add that, in judging the degree of excellence of a window, the co-operation of window-dressers and display men should be sought. Before forming definite conclusions on the conditions of lighting and desirable methods for certain classes of shops it would also be judicious to have the aid of the respective retailers' organizations. A small but representative joint committee of the Illuminating Engineering Society would no doubt be able to render useful service in this connection.

Recommendations on Industrial Lighting in Germany

IT is always useful to compare data from abroad with those in this country, and therefore the series of recommendations prepared by the Illuminating Engineering Society in Germany, which are completed on pages 130-2 in the present issue, deserve careful study.

The chief impression that one derives from an examination of these data is the close general agreement with conceptions of requirements in this country. Indeed, in some respects, particularly in regard to industrial lighting, the resemblance is remarkable. The conclusions were presumably arrived at after examination of those adopted by the Home Office Departmental Committee on Lighting in Factories and Workshops. We find, for instance, that for fine work a *minimum* of 30 lux, roughly equivalent to three foot-candles, is proposed, and for very fine work a minimum of 50 lux, equivalent to about five foot-candles. These values are substantially in agreement with those recommended, not as legal minima but as desirable minima in practice, by the Home Office Committee. The average desirable illumination is naturally put higher; for fine work it is put at about six to nine foot-candles, for very fine work at nine to twenty-five foot-candles—a range of values which seems to derive some support from the special tests on the relation between illumination and speed and accuracy of work summarized in our last issue.

In connection with glare the maximum brightness sources falling directly within the range of vision is put at 5-7·5 candles (Hefner) per sq. cm., which is certainly higher than the limit assigned in this country; but, like the Home Office Committee, they adopt an angle of 30° between the horizontal and the line from eye to source as the limit outside which sources of higher brightness may safely be used. Other recommendations in regard to avoidance of troublesome shadows on the work, etc., are, in general terms, similar to those proposed in this country.

The general trend of the recommendations and their resemblance to those contained in reports issued in this country and the codes of industrial lighting is evidence of the progress towards international agreement, as illustrated in the discussions at Geneva last year.

The Offices Regulation Bill

Good Natural and Artificial Lighting Specified

IN a communication received from Mr. William Keary, the General Secretary of the National Federation of Professional Workers, attention is drawn to the need for regulations ensuring proper hygienic conditions in offices, such as have for many years been applied to factories and workshops. The number of workers in offices—which has of late been increased by the influx of a considerable number of women—is very considerable. It is therefore an anomaly that office buildings do not come within the scope of the Factory Acts and that, in fact, there appear to be no regulations for their welfare. According to a schedule of mortality statistics, quoted by Mr. Keary, the ordinary commercial clerk comes 129th on a list of 180 occupations. He suggests that overcrowding, lack of cleanliness, inefficient lighting and heating, and the extension of underground premises are responsible for a great deal of preventable disease.

The copy of the Offices Regulation Bill, which the Federation is supporting, aims at ensuring precautions similar to those applying to factories. It provides for avoidance of overcrowding, adequate ventilation, proper sanitary arrangements, precautions for safety in case of fire, and the appointment of inspectors. We are particularly glad to observe that it is specified that offices "must be adequately lighted both by day and by night." No doubt this general requirement will be supplemented by more detailed recommendations. There can be no doubt that the lighting of offices requires supervision quite as much as the lighting of factories. It should be remembered that whereas modern factories are, in general, specially designed to ensure adequate access of daylight, many buildings converted to offices are not particularly favoured in this respect; in addition they are usually overshadowed by neighbouring buildings, and underground premises, requiring artificial light almost continuously, are frequently met with. Furthermore, clerical work, requiring sustained close vision, demands specially good illumination. We therefore welcome the introduction of this Bill containing a requirement for adequate lighting in offices, and we feel sure that the Illuminating Engineering Society would gladly render assistance in promoting a better standard of illumination.

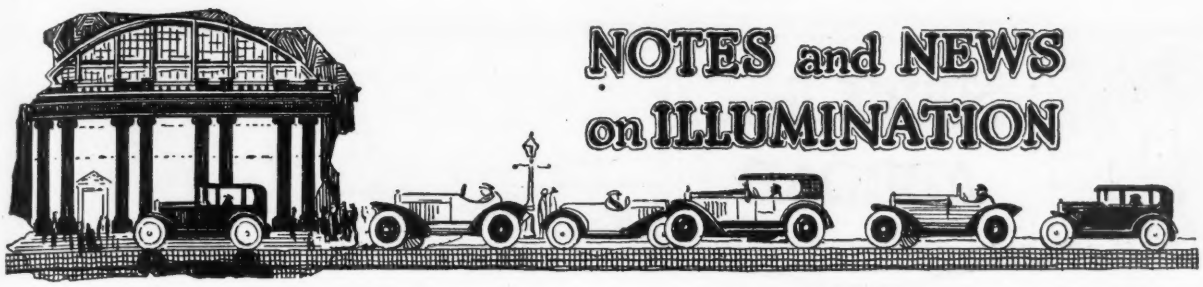
Lectures on Illuminating Engineering at the Polytechnic

(Regent Street, London)

BY the time this issue goes to press the course of lectures on Illuminating Engineering at the Polytechnic will be concluded. In this number we include abstracts of those delivered by Messrs. B. P. Dudding, J. G. Clark, P. J. Waldram, L. C. Martin, P. Kemp, and the initial lecture by the writer. In our next number we shall include abstracts of the four remaining addresses.

The lectures have dealt with a great variety of subjects and have been much appreciated. Some subjects naturally lent themselves better than others to demonstrations; we should like to make special reference to the very admirable demonstrations arranged by Mr. Clark in his lecture on Gas Lighting, and by Mr. Martin in his address on Colour in Illuminating Engineering. The display of gas lamps and lighting appliances served to give students a very good conception of the possibilities of modern gas lighting. Mr. Martin showed several delightful experiments, some of which we hope will be repeated before the Illuminating Engineering Society next session.

A feature has been the excellent and representative attendance, especially considering the period of the year. We were particularly glad to observe the presence of members of the staff of leading firms in the lighting industry, and their sympathetic support of the course was much appreciated. The success of the course has fully demonstrated the demand for information on illumination, and we understand that the Polytechnic is now arranging for a permanent course on Illuminating Engineering. The course will consist of a series of lectures on Wednesday evenings during the second year, and will again be under the joint auspices of the Illuminating Engineering Society and the Electrical Engineering Department of the Polytechnic. We trust that this enterprising step will be imitated by other educational institutions.



Artificial Light Treatment

A discussion at the Electrotherapeutical Section of the Royal Society of Medicine, on April 17th, brought out several points about the sources of light. Sir Henry Gauvain called light treatment the treatment apart from sunlight. It has not yet been established on scientific principles. On the results of practical experience with sunlight, it is a useful but costly supplement to this. Initial expenses and upkeep are both very great.

The original Finsen treatment, which is still adhered to in Sweden, is by means of open arc lamps. For his tuberculosis cases Gauvain uses as the chief means 75-ampere carbon arc-lamps, and each one serves for three recumbent and eight ambulant cases at a time. For the rickety cases. in which ultra-violet rays have been shown so valuable, he has mercury-vapour lamps. He was disappointed in their superficial effects, which, however, are enabled to penetrate more deeply by compressors used for blanching the skin.

Dr. Levick prefers the mercury-vapour lamps to the arc. Other parts of the spectrum than the short waves have effects, and by combining the mercury lamps with ordinary long-ray lamps there are better results. The debilitated and rickety feel enervated by the arc, whilst even the nurses feel the mercury lamps stimulating and vitalizing. Whilst this last method requires considerably more care in management it has advantages in the matter of economy.

Light-Signals on the Southern Railway

We understand that the Southern Railway has for some time been making experiments with methods of luminous signalling, and that automatic light-signals will be working next July at Charing Cross, Cannon Street and Holborn. The signal will consist of a concentrated beam of light from posts at the side of the line, clearly visible in bright sunlight, and the existing semaphore arms will thus be displaced. It is believed that the new system will enable trains to enter and leave stations much more quickly and enable traffic to be dealt with from a smaller number of boxes. The successful use of the device on the underground railways, where it has proved exceptionally serviceable during periods of fog, was mentioned in this journal some time ago.

Annual Meeting of the British Science Guild

The addresses delivered at the annual meeting of the British Science Guild, held at the Salter's Hall on April 22nd, were devoted very largely to the need for publicity in science. Sir William Bragg remarked that the 40 millions of people of this country were living on the direct applications of science, but they heard little of the progress that was being made. Scientific men spent most of their lives in researches and in the laboratory, and, unfortunately, not many of them have a gift for popular exposition. Major the Hon. H. Fletcher Moulton, later, pointed out that a similar situation exists in regard to industry. Manufacturers are blamed for being slow to avail themselves of the results of scientific researches. But there ought to be somebody to act as an intermediary and explain to them how they can benefit commercially from applied science. We hope that the Guild, which has already done so much to popularize science, will be successful in its efforts to create machinery to bridge this gulf. Methods of enlisting the aid of leading scientific and technical societies with a view to forming an educational and propaganda bureau are now being considered.

The Netherlands East Indies

ANOTHER FIELD FOR ILLUMINATING ENGINEERING.

At a meeting of the Circle of Scientific, Technical and Trade Journalists on April 28th, a most instructive paper on "The Future of Trade Expansion between Great Britain and the Netherlands East Indies" was read by Mr. P. C. Coote (Editor of *The Netherlands Indies Review*). Few people realize the importance and exceeding prosperity of the Dutch Indies and Malaya. Java alone now contains about 36 millions of inhabitants, and is almost as densely populated as the British Isles. There can be few places on the globe so richly endowed with lucrative industries—rubber, oil, tin, and tropical produce of all kinds. There is, therefore, an excellent field for trade, both with Europeans and natives (who in these islands seem to attain exceptional prosperity). In such a rich community there is doubtless readiness to take advantage of advances in lamps and lighting appliances. Important schemes of generating electricity are developing, whilst in the more remote parts portable illuminants should be welcome. One point mentioned by Mr. Coote deserves emphasis, however, the need for careful and sympathetic study of local tastes and requirements by the agents on the spot. Catalogues should be in Dutch, and prices in Dutch (and, with advantage, also in Chinese) coinage. Advertising should be done with the help of a local expert. Goods must be reasonably priced, and yet not "shoddy," but should, above all, be prepared to satisfy the whims and wishes of customers. Finally, as most of the retail trade is in the hands of the Chinese, the necessity of giving credit (in general quite justifiable) must be realized. All these facts were brought out in the discussion, in which Mr. Wynnand Wolff (Hon. Secretary of the Netherlands Chamber of Commerce in London) and Mr. Hutchinson (of the British Chamber of Commerce for the Netherlands East Indies) took part.

Information Bureaux and Specialist Libraries

In these days of specialization the collecting and analysing of literature on various sections of scientific and technical knowledge has become an important one. We are glad to note that the conference on this subject held at Hoddesden last September has resulted in financial support being obtained from the Carnegie United Kingdom Trustees for a period of two years in order to give the new movement an opportunity of becoming self-supporting. Mr. G. W. Keeling, formerly of Winchester and King's College, Cambridge, has been appointed organizing secretary to the committee, formed at the conference to ensure the continued co-operation of the interests there represented. Mr. L. Gaster, who attended the conference as a representative of the Scientific and Technical Circle of the Institute of Journalists, was elected a member of this committee, and no doubt the desirability of collecting literature on illumination will receive attention. As yet we have no readily accessible and complete library on illumination. The establishment of such a library would be a welcome advance. In the work of assembling data on patents and developments in various industries the technical press should be able to render useful service. A second week-end conference is to be held next September, when an opportunity of reviewing progress will be presented.

Such libraries would be of considerable industrial value, and we trust that the movement will receive sympathetic support.

The International Exhibition of Gas and Water Industries

Our attention has been drawn to the above International Exhibition, which is to be held in Padua from June 5th onwards, at the same time as the International Samples Fair in the same city. Associated with the exhibition there will be a congress for the purpose of reviewing scientific and technical developments, and the co-operation of leading technical bodies in other countries has been invited. The field to be dealt with is a wide one, but we notice that a special section is allotted to public and private lighting by gas. Further particulars are obtainable from the secretary of the Executive Committee, Sig. L. Astolfi, Mostra Internazionale dell'Industria del Gas E dell'Acqua, Padova, Italy.

A Russian Book on Illumination

The general development of interest in illumination in all countries is strikingly illustrated by a book which the author, Mr. Michael Zelentsoff, who is associated with the Leningrad Electrotechnical Institute, has sent us for review. The work is published in Russian, and we propose to publish a survey of its contents in due course. Meantime we observe that there are 432 pages of matter, and that such matters as the effect of light on the eye, photometry, electric lamps, shades and reflectors, and practical lighting problems are dealt with. The bibliography at the end of each chapter also shows that the author is familiar with developments in other countries. It is surely a sign of the times that a work of this size, devoted entirely to illumination, should be published in Russia, and we look forward to hearing further particulars of progress in illuminating engineering in that country.

Freak Lighting Installations

In parts of the United States curious examples of "freak" lighting are to be found. Some of these are illustrated by Mr. A. L. Spring in a recent issue of the *Electrical World*. Sierra Madre, a little city in California, has a beautiful setting of oak trees, and it was felt that amongst these, ordinary lamp posts would be unsightly. The designers solved the problem by lighting standards shaped like rustic oak, each carrying a lighting unit in the form of an acorn! Similarly, in the public park at Ojai lighting is effected by units mounted on branches of the trees from 20 to 75 feet from the ground. At Altadena, California, "Christmas Trees Avenue," lined with beautiful cedar trees, receives special illumination at the festive season. From December 20th to New Year's Eve each year every other tree is decorated from top to bottom with coloured lamps. Perhaps, however, the most singular form of public lighting mentioned was that adopted by an enterprising tract owner who installed lights immediately over the curb, with protecting concrete arches above them. This form of lighting would doubtless harmonize with the views of those people who, whenever a fog occurs, write to the papers arguing that public lamps are too high. In this instance the novelty does not seem to have proved a success—for the lamps proved too popular as targets for stone-throwing boys in the neighbourhood!

Pioneering Work on the Limelight and the Optical Lantern

It does not seem to be generally known that the discovery of the limelight and its application to the "magic lantern" originated mainly in this country. A review of work in this field about 100 years ago, recently contributed by Mr. F. Paul Liesegang to the Illuminating Engineering Society in Germany, bristles with English names. It appears that Dr. Birckbeck, in 1824, in London, first exhibited the use of the limelight for projecting pictures. Gurney, in a lecture before the Surrey Institution in 1822, drew attention to the possibilities of the light, which he believed had a great future in the theatre and especially for lighthouses. Drummond's practical experiments about 1825 led to the description of the "Drummond Light," which he tested for lighthouse work. Even after Birckbeck's demonstration the application to the lantern was not immediate. In 1830 David Brewster, judging from his remarks in a treatise on the optical lantern, seemed to regard the light as dangerous. J. T. Cooper and John Carry, after witnessing Birckbeck's demonstration, suggested the use of limelight with the microscope, and in 1833 there was a display which attracted much public interest. By 1841 two daily demonstrations in different "galleries of practical science" were being given.

Are Neon Signs Glaring?

The rapid introduction of neon tube designs in the streets of Continental cities appears to have given rise to some discussion whether such signs are liable to cause glare, and thus prove detrimental to the safety of traffic. Dr. H. Lux, in *Licht und Lampe*, contributes an investigation on this point. He points out that the usual assumption that the exposure to the eye of sources of brightness exceeding 0·75 H.K. per sq. cm. causes glare, and does not take sufficient account of the relative brightness of surroundings. In a street it is necessary to compare the brightness of exposed sources with that of adjacent surfaces. A calculation on these lines leads to the conclusion that the brightness of the neon tube only attains half the value liable to cause dazzle. Approaching the problem from a different aspect—the formation of "after-images"—the author comes to the same conclusion, though it is to be noted that the influence of colour of light in relation to after-images has not yet been fully studied. We might add that a flashing sign is presumably to be differently regarded from a steady one. Generally speaking, in streets carrying crowded traffic, one would prefer signs of steady brightness, at all events if they fall within the normal range of vision.

Personal

We are informed that on and after May 4th Messrs. J. F. Crowley & Partners are removing from 16, Victoria Street to 11, Queen Anne's Gate, Westminster. In addition to the usual office accommodation, well-equipped chemical and physical laboratories for research purposes will be available. The telephone number will be the same as before (Vic. 5670 and 5671), but the telegraphic address will be "Cusec Parl, London." Our readers will doubtless join us in wishing success to Dr. Crowley, a member of the Council of the Illuminating Engineering Society, in which he has always taken a great interest, and before whom he read a most instructive paper on applications of intermittent synchronous light to industry at the annual meeting last year.

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

A Survey of Lighting in Retail Shops

(Proceedings at the Meeting of the Society held at the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, London, at 7 p.m. on Tuesday, May 19th, 1925.)

A MEETING of the Illuminating Engineering Society was held, by kind invitation, at the E.L.M.A. Lighting Service Bureau, (15, Savoy Street, London), at 7 p.m. on Tuesday, May 19th, Mr. C. W. Sully presiding.

The minutes of the previous meeting having been taken as read, the Hon. Secretary read out the names of the following applicants for membership:—

Elliott, S. G. .....Lighting Engineer, Underground Railways, 30, The Green, Kew, Surrey.

Fottrell, E. J. .....Joint Manager, National Gas Council, 28, Grosvenor Gardens, S.W.1.

Goodwin, F. W. .....Electrical Engineer, Minerva, Benhill Avenue, Sutton, Surrey.

Hall, H. J. .....Engineer and Manager of the Electric Street Lighting Apparatus Co., 27, Castle Street, Canterbury.

Morton, C. A. .....Research Laboratories of the G.E.C. Tech. Asst., 32, Ravenscroft Street, Hackney Road, E.2.

Ogilvie, S. S. .....Joint Manager of the National Gas Council, 28, Grosvenor Gardens.

Payne, Wm. .....Chief Inspector of the Commercial Gas Co., 73, Ladysmith Avenue, Seven Kings, Essex.

Robinson, G. W. ..... Manufacturing Electrical Engineer, 39, Gt. Windmill Street, W.1.

Smith, W. J. ..... Secretary of the National Gas Council, 28, Grosvenor Gardens, S.W.

Taylor, J. C. ..... Staff Office, Gas Light and Coke Co., "Rodmersham," 7, Albert Row, Hendon, N.W.4.

Watson, P. J. .....Member of the staff of Holophane, Ltd., 56, Stoneleigh Road, Birchfield, Birmingham.

Watson, H. J. ..... Electrical Engineer, Turl Street, Oxford.

Hawkins, J. Mortimer...Electrical Engineer, 76, Buckthorne Road, Crofton Park, S.E.

The names of applicants announced at the previous meeting were read again, and these gentlemen were formally declared members of the Society.

The Chairman then called upon Mr. W. J. Jones to read the paper by himself and Mr. H. Lingard, which was as follows:—

A Survey of the Lighting of 800 Retail Shops

By W. J. JONES and H. LINGARD

INTRODUCTION.

IT is now a generally accepted fact that artificial light plays an enormous part in the merchandising of goods after sunset, and it can readily be shown that good illumination has a definite cash value to the shopkeeper. In spite, however, of the excellent work accomplished by this Society since its inception, there is probably no other field in which light is still so badly mismanaged. Glare is ubiquitous, and a large percentage of the light flux emitted by the lamp itself is either wasted or rendered ineffective. Many illuminating engineers are of the opinion that this misuse of light on the part of shopkeepers acts as a brake on better lighting in general, for what the public see to be common in the shop window is not felt instinctively to be out of place in the home, office or workshop. If glare were less common its detrimental effect would be more readily perceived. The lighting of shop windows has been the subject of several previous discussions before this Society,* while in America the subject of shop lighting in general has been treated most exhaustively. It is not proposed in this paper to discuss the lighting of shops in detail, except in so far as the information obtained from this survey demands.

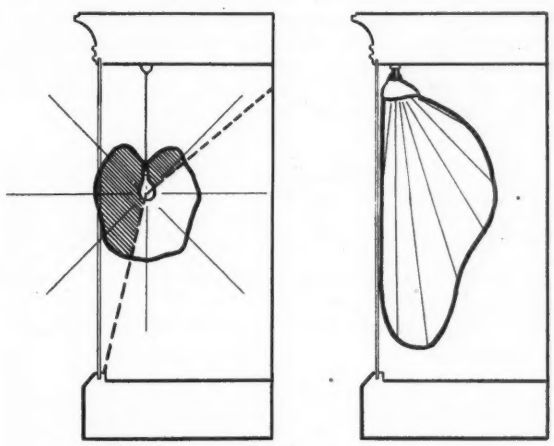


FIG. 1.

Bare lamp in window, ¾ light wasted.

Top reflectors, all light used.

PREVIOUS SURVEY.

Last year a simple survey of 10,000 shop windows was made in order to gauge the prevalence of glare. It was found that no less than 66 per cent. of the shop windows of the country had exposed filaments and that the equipment in general was antiquated and entirely unsatisfactory for the use of gasfilled lamps. In multitudinous instances the gasfilled lamp, with its intrinsic brilliancy of 4,000-5,000 candles/sq. in., was being used with reflectors and fittings designed originally for the old carbon lamp of an intrinsic brilliancy of 400 candles/sq. in. Apparently the shop-

* See N. W. Prangnell, "Shop Lighting by Electricity," *Illuminating Engineer*, Vol. V., 1912, p. 125; E. Stroud, "Show-Window and Spectacular Lighting," *Illuminating Engineer*, Vol. XIV, 1921, p. 63; Miss M. Partridge, B.Sc., on "The Use of Light in Shops, Show-Windows and for Display Purposes," *Illuminating Engineer*, Vol. XVII, 1924, p. 44.

keeper has been swift to realize the improvement in quantity and quality of the light emitted from the gas-filled lamp over the older types, but has not appreciated the need for effectively screening the filament of a light-source that is ten times as bright. Furthermore, it apparently is not realized that of the available light flux from a bare lamp in a window, only one-third illuminates the goods (see Fig. 1), the remainder of the light lighting up the ceiling or passing through the window to the street.

It was felt that, although this survey revealed these unsatisfactory conditions, much more was required, and for this reason a detailed survey of conditions in approximately 800 retail shops was undertaken. The survey was carried out by two experienced investigators using the simple foot-candle meter, an instrument which is both extremely portable and sufficiently accurate for the purpose. The survey definitely excluded large departmental stores, as it was thought that the conditions prevailing in these establishments were exceptional. Moreover, the lighting arrangements of such premises would require much more detailed description than would be possible in this paper. This field of illumination merits a paper of its own.

The shops surveyed were chosen more or less indiscriminately, some in main thoroughfares, others in side streets, while attention was also paid to shops in suburban areas. For example, the lighting conditions in a whole block of shops was taken, the surveyor dealing with each shop in turn. In London, for instance, shops in the following districts were investigated:—

District.	No. of Shops.	No. in Main Street.	No. in Side Streets.
St. Marylebone ...	62	39	23
Croydon	79	47	32
Hackney	106	96	10

and in Cardiff 99 shops were surveyed, of which 69 were in the central area and 30 in the suburbs.

Conditions in nine towns were studied as follows:—

Name of Town.	No. of Shops Surveyed	No. in Main Street.	No. in Side Streets.
London—			
Croydon	79	47	32
Hackney	106	96	10
St. Marylebone ...	62	39	23
Cardiff	99	73	26
Glasgow	97	86	11
Eastbourne ...	65	53	12
Gloucester	32	25	7
Bristol	108	69	39
Sheffield	15	15	—
Norwich	99	85	14
Birmingham ...	72	52	20
Totals	834	640	194

Questionnaire Forms.

It was thought important to have survey forms, which gave as much information as possible and yet were easily filled in. Fig. 2 shows the type of questionnaire form employed. Detailed information of the shop window installation was thus obtained, also the method of lighting the interior, four readings being taken of the foot-candle intensity of illumination on the counter, or in the case of boot shops, the foot-stool. The data obtained from a shop is sufficiently complete to enable a mental picture of the installation to be obtained. Other points considered were the frequency with which particular types of equipment recurred, the predominance of the use of gasfilled lamps and the type of window dressing, whether close or display, and the nature of the decorations.

Analysis.

The collated data from the questionnaire booklets was then copied on analysis forms, each shop being indexed so that easy reference to the original could be made if necessary. Columns are given in the window section for the computed values of watts/ft. run and indications of the figure of merit allotted to the lighting of the window, whether excellent, good, fair or poor. Below is given the method of arriving at the degree of excellence, a lower watts/ft. run being allowed for a side street.

PLEASE DO NOT DETACH SHEET

DATE ..... ELMA Ref. .....

NAME AND ADDRESS OF SHOP .....

TYPE OF SHOP .....

CLOSING HOURS .....

SHOP INTERIOR		SHOP WINDOW	
IS SHOP IN MAIN STREET ☐ SIDE STREET ☐	HAS SHOP DEPARTMENTS YES ☐ NO ☐	HAS SHOP A WINDOW YES ☐ NO ☐	NUMBER OF WINDOWS .....
SIZE OF ROOM LENGTH .....Ft BREADTH .....Ft HEIGHT .....Ft	IS DECORATION LIGHT ☐ MEDIUM ☐ DARK ☐	ESTIMATED LENGTH OF WINDOW ..... Feet	IS LIGHTING BY DROP PENDANTS ☐ TOP REFLECTORS ☐
TOTAL NUMBER OF UNITS	ARE LOCAL LIGHTS USED OVER COUNTER YES ☐ NO ☐	TOTAL NUMBER OF LAMPS	IS COLOUR USED FOR LIGHTING YES ☐ NO ☐
DESCRIPTION AND NUMBER OF LAMPS GASFILLED ☐ VACUUM ☐ CLEAR ☐ FROSTED ☐ WHITE ☐	WATTAGE AND NUMBER OF LAMPS 20 WATT ☐ 30 " ☐ 40 " ☐ 60 " ☐ 100 " ☐ 150 " ☐ 200 " ☐ 300 " ☐	DESCRIPTION & NUMBER OF LAMPS GASFILLED ☐ VACUUM ☐ CLEAR ☐ FROSTED ☐ WHITE ☐	WATTAGE AND NUMBER OF LAMPS 20 WATT ☐ 30 " ☐ 40 " ☐ 60 " ☐ 100 " ☐ 150 " ☐ 200 " ☐
DESCRIPTION AND NO OF PENDANTS Bare Lamps ☐ Clear Glass Reflectors ☐ Frosted " " ☐ Prismatic " " ☐ Conical Opal " ☐ Bell " " ☐ Ornamental " " ☐ Semi-Indirect Bowls ☐ Totally Enclosed Glassware ☐ Totally Indirect Fittings ☐	ARE SHOWCASES IF ANY, LIGHTED YES ☐ NO ☐ INTENSITY TESTS ON COUNTER READING 1 ..... F.C. " 2 ..... F.C. " 3 ..... F.C. " 4 ..... F.C.	DESCRIPTION AND NUMBER OF PENDANTS Bare Lamps ☐ Clear Glass Reflectors ☐ Frosted " " ☐ Prismatic " " ☐ Conical Opal " ☐ Bell " " ☐ Ornamental " " ☐ Semi-Indirect Bowls ☐ IS WINDOW DRESSING Closed Window Type ☐ Display Type ☐	DESCRIPTION AND No OF TOP REFLECTORS IF USED Opal Glass ☐ Prismatic " ☐ Metal ☐ Silvered Glass Troughing ☐ OUTSIDE LIGHTING NUMBER OF UNITS ☐ LANTERNS ☐ REFLECTORS ☐ WATTAGE ☐
IS THERE AN OUTSIDE ELECTRIC SIGN { YES ☐ NO ☐		IS WINDOW LIGHTED AFTER CLOSING TIME { YES ☐ NO ☐	

REMARKS

FIG. 2.

Estimation of Degree of Excellence of Shop Window Lighting.

METHOD OF JUDGING THE LIGHTING OF A SHOP WINDOW.

		Main Street.	Side Street.
Excellent.	Top Reflectors.	90 watts per foot run and over.	45 watts per foot run and over.
Good.	Top Reflectors.	50-90 watts per foot run.	25-45 watts per foot run
Fair.	Top Reflectors.	20-50 watts per foot run.	10-25 watts per foot run.
	Prismatic and Diffusing Glass Drop Pendants.	50 watts per foot run and over.	25 watts per foot run and over.
Poor.	Top Reflectors.	Under 20 watts per foot run.	Under 10 watts per foot run.
	Prismatic and Diffusing Glass Drop Pendants.	Under 50 watts per foot run.	Under 25 watts per foot run.
	Glare of any kind.	Any wattage per foot run.	Any wattage per foot run.

It may be argued that this method of judging is an arbitrary one, but in any case it does form a definite basis of comparison.

Windows having either bare gasfilled lamps or gas-filled lamps in conical opal or clear glass shades are designated poor, and whenever pendants with prismatic or diffusing reflectors are in use, no matter the wattage of the lamps employed, we thought such installations could not be called better than fair. Undoubtedly the higher figures of merit should be reserved for windows that are lighted from concealed sources, either by troughs or specially designed window reflectors.

Referring to the interior, the analysis form provides a column giving the average of the several foot-candle measurements at the counter and the watts per square foot of floor area. The summation of these results reveals an interesting set of general conditions which are worthy of discussion.

General Conditions.

Lamps.

The results confirm the impression given by the previous survey that the shopkeeper has been quick to avail himself of the more efficient gasfilled lamp,

ANALYSIS OF SHOP LIGHTING

INTERIOR

Serial No.	Total	5832
Closing Hour		640
Street Type: Main Street		194
Street Type: Side Street		84
Departments		18897
Size of Interior: Length		12825
Size of Interior: Breadth		9601
Size of Interior: Height		308886
Area in sq. ft.		415260
Total Watts		157
Decoration: Light		358
Decoration: Medium		312
Decoration: Dark		4047
No. of units		362
No. of Local Lights		3172
Description and No. of Lamps: Gasfilled		889
Description and No. of Lamps: Vacuum		3933
Description and No. of Lamps: Clear		20
Description and No. of Lamps: Frosted		99
Description and No. of Lamps: White		—
Wattage and No. of Lamps: 20		6
Wattage and No. of Lamps: 30		206
Wattage and No. of Lamps: 40		1271
Wattage and No. of Lamps: 60		1764
Wattage and No. of Lamps: 100		214
Wattage and No. of Lamps: 150		366
Wattage and No. of Lamps: 200		127
Wattage and No. of Lamps: 300		483
Description and No. of Pendants: Bare Lamps		13
Description and No. of Pendants: Clear Glass		224
Description and No. of Pendants: Frosted Glass		1212
Description and No. of Pendants: Prismatic Glass		653
Description and No. of Pendants: Conical Opal		246
Description and No. of Pendants: Bell Opal		231
Description and No. of Pendants: Ornamental Opal		574
Description and No. of Pendants: S. Indr. Bowls		285
Description and No. of Pendants: T. Enclg. units		29
Description and No. of Pendants: T. Indr. units		—
Description and No. of Pendants: Cornice and Special		19
Showcases Lighted		4909
Foot-candle Intensity		833
No. of Interiors		—
Value of Lighting: Excellent		—
Value of Lighting: Good		—
Value of Lighting: Fair		—
Value of Lighting: Poor		

WINDOW

Serial No.	Total	1231
No. of Windows		916
Length of Windows		9
No. of Drop Pendants		600
No. of Top Reflectors		207
No. of Lamps		4234
Colour used		9
Description and No. of Lamps: Gasfilled		3447
Description and No. of Lamps: Vacuum		788
Description and No. of Lamps: Clear		4127
Description and No. of Lamps: Frosted		51
Description and No. of Lamps: White		65
Wattage and No. of Lamps: 20		—
Wattage and No. of Lamps: 30		1
Wattage and No. of Lamps: 40		271
Wattage and No. of Lamps: 60		1242
Wattage and No. of Lamps: 100		2447
Wattage and No. of Lamps: 150		82
Wattage and No. of Lamps: 200		90
Description and No. of Drop Pendants: Bare Lamps		709
Description and No. of Drop Pendants: Clear Glass		—
Description and No. of Drop Pendants: Frosted Glass		88
Description and No. of Drop Pendants: Prismatic Glass		754
Description and No. of Drop Pendants: Conical Opal		283
Description and No. of Drop Pendants: Bell Opal		148
Description and No. of Drop Pendants: Ornamental Opal		185
Description and No. of Drop Pendants: S. Indr. Bowl		104
Description & No. of Top Reflectors: Opal Glass		59
Description & No. of Top Reflectors: Prismatic Glass		254
Description & No. of Top Reflectors: Metal		68
Description & No. of Top Reflectors: Silvered Glass		617
Description & No. of Top Reflectors: Trough		214
Window Display: Close Type		341
Window Display: Display		434
Outside Reflectors: No. of Units		374
Outside Reflectors: Lanterns		349
Outside Reflectors: Reflectors		25
Outside Reflectors: Wattage		31630
Outside Sign		51
After-hour Lighting		116
Watts per Foot-run		—
No. of Shops		779
Value of Window Lighting: Excellent		50
Value of Window Lighting: Good		86
Value of Window Lighting: Fair		166
Value of Window Lighting: Poor		475

particularly in the shop window. Indeed, it is rare in a busy thoroughfare where electrical energy is available to find any other source of light being used. It was reported by Mr. C. W. Sully in his recent paper on "Progress in Electrical Illumination," read at the World Power Conference at Wembley, that the average wattage of the lamps used in this country had increased considerably during recent years, and these figures form a useful comparison with the average wattage used in shops which this survey reveals.

In 1912 the average wattage of lamps used in this country was	36·1 watts.
In 1917 the average wattage of lamps used in this country was	48·8 ,,
In 1922 the average wattage of lamps used in this country was	57·4 ,,
Average wattage of lamps used in shop windows (1925)	85·5 ,,
Average wattage of lamps used in shop interiors (1925)	102 ,,

The following percentages of the different wattage lamps in use show that the 100-watt lamp is most frequently used, closely followed by the 60-watt size.

TABLE I.

Shop Windows. Size of Lamp.	Per cent.	Shop Interiors. Size of Lamp.	Per cent.	Combined. Size of Lamp.	Per cent.
40-watt ...	6	40-watt ...	5	40-watt ...	5·5
60-watt ...	30	60-watt ...	32	60 watt ...	31
100-watt ...	60	100-watt ...	45	100-watt ...	52·5
150-watt ...	2	150-watt ...	6	150-watt ...	4
200-watt ...	2	200-watt ...	9	200-watt ...	5·5
300-watt ...		300-watt ...	3	300-watt ...	1·5

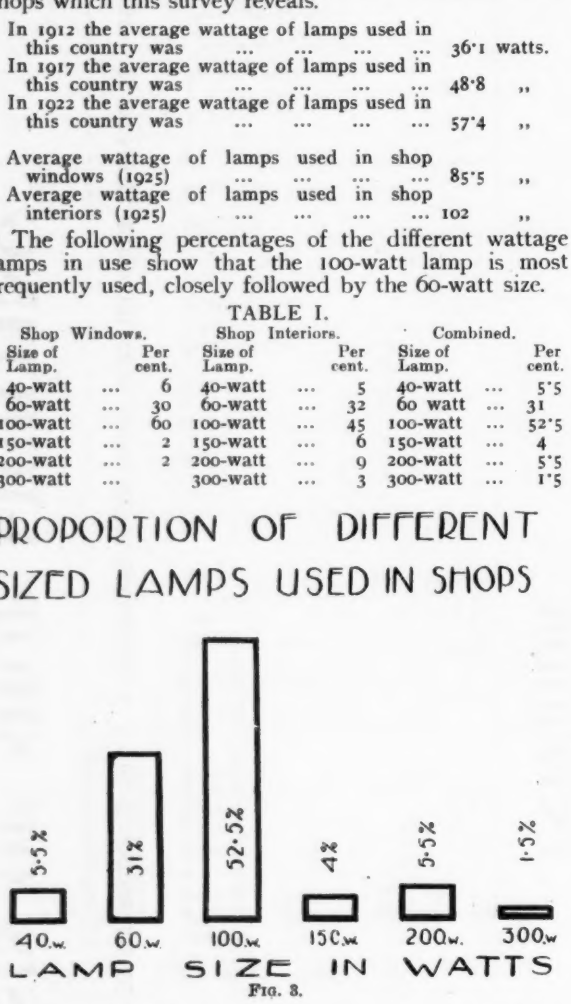


Fig. 3.

The gradual increase in the size of lamp used has been amply shown by Powell (Transaction of the I.E.S. (U.S.A.), July, 1922), who made two surveys of conditions prevailing in America, the first in 1912 and the second in 1922. He found that the wattage of the most commonly used lamp had doubled in the period of ten years, in spite of the simultaneous improvement in the efficiency of lamps, clearly indicating the demand for a higher standard of illumination, and it is safe to assume that a similar advance is taking place in this country.

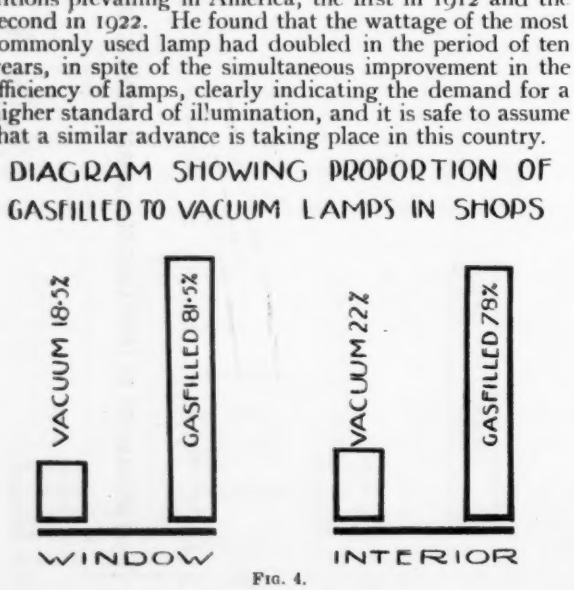


Fig. 4.

The relative percentages of gasfilled and vacuum type lamps given below are overwhelmingly in favour of the former.

It has been calculated from this survey that the average total wattage used per shop is 1,060, and if one estimates the number of shops in the country as being 574,360 (C. W. Sully—"Progress in Electrical Illumination"), it is easy to see that the total capacity of electrical plant for shop lighting alone should be no less than 610,000 K.W.

Shop Windows.

Fittings.

The general use of the gasfilled lamp has resulted in many instances of glare due to the following causes:—

(1) Use of clear gasfilled lamps without reflectors.
(2) Use of clear gasfilled lamps with conical opal shades.
(3) Use of clear gasfilled lamps with clear glass or frosted glass shades, often insufficiently deep to even cover the lamp.
(4) Use of clear gasfilled lamps with prismatic and diffusing reflectors of the wrong size.

For the purpose of this survey only those instances coming under the heading of 1-3 were considered as sources of glare, since the differentiation involved under heading 4 would have meant further complication. The following table gives the frequency of use for different types of equipment:—

Top reflectors	35 per cent.
Drop pendants with prismatic or diffusing shades	36·5 ,, ,,
Sources of glare	28·5 ,, ,,

Illumination.

The survey reveals how very few of the shop windows investigated can be considered satisfactorily lighted. It would appear that in many instances the wattage employed is ample, but that the effective use of the luminous energy emitted by the lamp is poor. Judged by the standard described, comparatively few shops are well lighted. In actual percentages only 17·5 per cent. reach or exceed this level, thus leaving 82·5 per cent. either poor or fair. Not less than 28 per cent. of those classified as poor would immediately be eligible for a higher classification if the lamps had been provided with effective reflecting equipment. The tables indicate the urgent need for action on the part of illuminating engineers in the sphere of shop window lighting.

Degree of Excellence.	Percentage of Shops.
Excellent	6·5
Good	11·0
Fair	21·5
Poor	61·0

Is it not surprising that although, for the average shop window, the most effective illumination may be obtained for the modest outlay of 6d. or less per hour, so little advantage is taken of this great opportunity to attract customers? It would appear that either the shopkeeper does not realize that such lighting can be readily obtained or he is misinformed as to the cost. The following general statistics relating to shop windows are of interest:—

Number of show windows surveyed ...	780
Average length of window	11·5 ft.
Average watts per foot run of window ...	39·3
Number of lamps per window	5·3
Per cent. using after-hour lighting	15
Per cent. using outside sign	6
Per cent. using colour lighting	1·1
Per cent. type of window dressing (close) ...	44
Per cent. type of window dressing (display)	56

It is reported by central station engineers that more and more shopkeepers are taking advantage of the special rates for electricity that are available for lighting windows after closing time. The figure of 15 per cent. should therefore be considerably increased in the near future, and one anticipates the brightening of our cities by the general adoption of after-hour lighting.

The introduction of colour in lighting as a means of attraction has not yet been fully realized by the shopkeeper, and we are of the opinion that this method of illumination will receive more attention in the future.

Shop Interiors.

Fittings.

The drop pendant is still by far the most common means of lighting the interior of shops, although there is good reason for believing that it is rapidly being supplanted by units giving general illumination. Although illumination is essentially required on the counter of a shop, a considerable flux of light is desirable in all directions in order to create the impression of brightness and to make the interior appear spacious and attractive. There is an increased tendency on the part of shopkeepers to make extensive displays of goods in the interior. The drop pendant, providing local lighting on the counter, was partially efficient so long as the vendor stored most of his products in drawers and cases, but this new tendency necessitates a high standard of illumination in all parts of the shop. A purchaser can then readily perceive other requirements, in addition to those for which he primarily entered the shop. It is for these reasons that a large number of progressive shops, particularly those engaged in certain classes of trade, have given up the old-fashioned system of multitudinous drop pendants dating back to the time when only lamps of limited candle-power were available, and have installed altogether larger light-sources and abandoned pendants placed immediately over the counter. Only 43 per cent. of the shops inspected had local lights over the counter.

When the semi-indirect bowl fitting was first introduced it did in a large measure meet a great need, and was used in many installations. Unfortunately the depreciation of such a lighting system is very great, due to the settlement of dust and insects upon the reflecting and light-transmitting surfaces. Fig. 5 shows how great

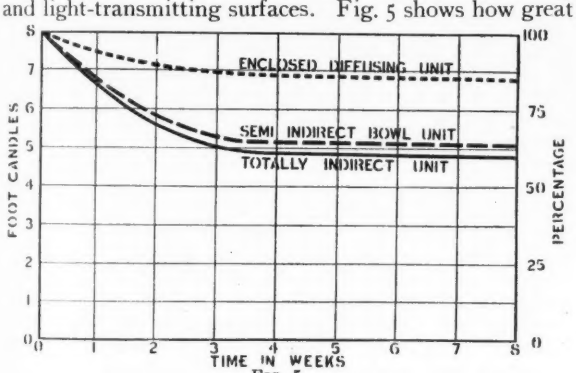


Fig. 5.

is the drop in the efficiency of such a system, since within four weeks the illumination falls off 40 per cent. Although the percentage of totally enclosed diffusing fittings in use is not at present very large, there is every reason to suppose that it is the type of equipment which will find most favour in the future. Since dust can only settle on the top of the glassware the depreciation in illumination is comparatively small, for transmission in a downward direction is unimpeded. There is an additional advantage accruing to the use of totally enclosed equipment; the life of the lamp is, in effect, prolonged, since the lamp itself is less frequently handled for cleaning.

Types of Equipment in Use.	Percentage of Shops
Totally enclosing units	5·2
Semi-indirect bowls	16·5
Diffusing shades, including prismatic reflector	41
Bare lamps, clear glass shades, conical opal shades	36

Illumination of Interiors.

The average illumination in the shops under consideration was found to vary enormously; 11 per cent. had 10 foot-candles and over, 51 per cent. 5-10 foot-candles, and 38 per cent. 5 foot-candles or under. Except when otherwise specified, the readings were taken on the counter. It can be taken as a good rough rule that, under ordinary conditions as regards dimensions of shop, colour of surroundings, etc., 5 foot-candles will be obtained for every watt per square foot of electrical energy used. This figure is also confirmed by Powell.

During the investigation note was made of the condition of the interior, whether the ceiling and walls could be termed light, medium or dark. The following gives the percentages under these headings:—

Nature of Internal Decoration.

Light	19 per cent.
Medium	43 ,, ,,
Dark	38 ,, ,,

Show-case Lighting.

One feels instinctively that show-cases should be well lighted (it has been suggested that it is necessary to illuminate them to double the intensity of the shop itself), and one is therefore disappointed that only 2·3 per cent. of the shops had any lighting in show-cases at all. It is well known that daylight reflections in shop windows almost entirely discount their effectiveness, and the majority of show-cases in the interior, during the daytime, suffer from the same disadvantage. Furthermore, at night-time the same show-cases when under artificial light have these disadvantages accentuated. Fig. 6 illustrates the photograph of a shop interior and well indicates the manner in which the reflections prevent the customer from seeing the goods that are displayed in the show-cases. One would, therefore, imagine that the introduction of show-case lighting during daytime, and more particularly under artificial light, would materially add to the efficiency of a shop.

Fig. 6.

General Data.

Number of shop interiors investigated	827
Average area of shop (square feet)	374
Average watts per shop	1,060
Average foot-candles	5·9
Average watts per square foot	1·3

Conditions in Certain Trades.

Quite early in the survey it was realized that certain types of shops had made more progress in matters of illumination than others, and in order to elicit more information on this score a further analysis as per Fig. 7 was made. The conditions were investigated for ten different classes of shops, and some interesting data was found both regarding the lighting of the windows and also the interiors.

Windows.

Fig. 8 gives a number of diagrams which clearly show the degree of excellence of the lighting in any one of the ten trades, and it will be noticed that there is a wide diversity of conditions. On the whole the tobacconists, provision merchants, butchers, confectioners, chemists and jewellers are the worst lighted, where between 64 and 76 per cent. are designated "poor," chiefly owing to the prevalence of bare lamps. This is particularly true in the cases of chemists and jewellers. The diagrams indicate the vast amount of work which has to be done in several trades in order to bring the values of illumination up to a reasonable standard. Tailors and boot shops stand out as being better illuminated than the others. The reason for this is shown in Fig. 9, which readily gives the prevalence of different types of equipment. Top reflectors are most commonly used in boot shops, outfitters and drapers, and least used by provision merchants, confectioners and tobacconists.

TYPE OF SHOP TOBACCONIST. ELNA SURVEY NO 1
NO. DETAILED 63. MISCELLANEOUS SHOPS

SERIAL	WINDOW: EXCELLENT	GOOD	FAIR	POOR	TOP REFL'R	OTHER TYPE	BARE LAMPS	LENGTH	WATTS	DISPLAY	INTERIOR: AREA	WATTS	OVER 10 F.C.	5-10 F.C.	UNDER 5 F.C.	LOCAL LIGHTING
2653	×				×			6	320	×	180	200			×	×
2663			×			×		20	600		300	120		×		×
2672				×		×		10	220		220	300		×		
2678			×			×		10	300		224	200			×	×
2615			×			×		6	120	×	100	60			×	×
2026				×		×		10	400		300	200			×	
2527				×			×	10	300		270	260		×		×
2534				×			×	9	150		216	120			×	×
2538		×			×			9	400		180	200			×	
2482				×			×	20	280		336	160		×		×
2492			×		×			10	400		300	240	×			×
2506				×				16	300	×	300	200		×		×
2883				×			×	12	400		168	140			×	
2886				×			×	14	360		280	420		×		×
2892				×	×			14	200		240	100			×	
2907			×		×			8	300		390	200			×	
2910			×		×			11	440		360	200			×	×
2940				×			×	11	340		220	210		×		×
2957				×			×	11	120		100	100		×		
2958			×		×			12	300		326	250	×			×
2968			×		×			10	200	×	540	200			×	×
3042				×		×		8	200	×	280	100		×		×
2981				×			×	22	600		252	340		×		×
2992				×			×	10	340		336	300			×	
3004				×			×	8	300		192	200		×		
3009		×			×			10	480		198	480			×	
3020				×			×	10	180		168	120			×	
TOTAL	1	2	9	16	9	6	11	307	8590	5	6976	5640	2	11	14	16
BT. FWD.	1	2	7	25	3	11	21	275	10300	12	5071	9910	1	16	16	22
GD. TOTAL	2	4	16	41	12	17	32	582	18890	17	12047	15550	3	27	30	38

WINDOW WATTS/FT. RUN = 32·5 (AVG) MAX. F.C. = 14·5
INTERIOR WATTS/15 = 1·29 MIN. F.C. = 2·75
DISPLAY DRESSING 63% %POOR = 65 %FAIR = 25·3 %GOOD = 6·4 %EXCELLENT = 3·2
GENERAL LIGHTING 38% %OVER 10 F.C. = 5 %5-10 F.C. = 45 %UNDER 5 F.C. = 50

FIG. 7.

Window Dressing.

There is a tendency at the present day for greater care to be taken in the dressing of shop windows, and on a whole there is a definite movement towards the display type of dressing as opposed to placing goods close up to the window. This tendency is of enormous importance to good illumination, as it enables scientific principles of illumination to be more readily applied. Fig. 10 indicates the percentage of shops in different trades with display window dressings, and, as one would expect, the jeweller is at the bottom of the chart. This fact is reflected in the figures referred to above, for it is

PROPORTION OF DIFFERENT TYPES OF EQUIPMENT USED IN SHOP WINDOWS

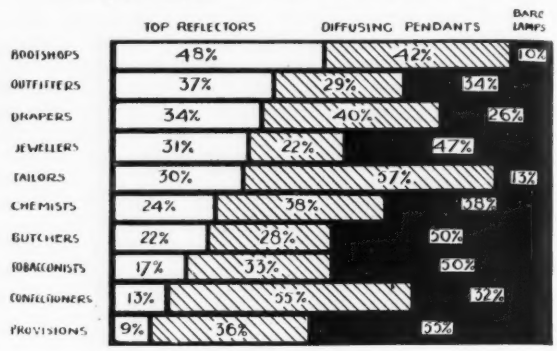


FIG. 9.

exceedingly difficult to light a jeweller's window satisfactorily when the merchandise is disposed so close to the front. Similar criticism can be made of the chemist, outfitter and tobacconist. Tailors and drapers are learning the importance of display dressing, while provision merchants, butchers and confectioners, by the very nature of their goods, are forced generally to adopt display methods of dressing. In these last cases it is not so much the general character of the window dressing which plays such an important part in the poorness of the illumination obtained as the ignorance of the methods of controlling light effectively, coupled with the fact that the shops are usually quite small.

Shop Interiors.

An analysis of the frequency of the use of types of fittings shows that glare is not quite so prevalent in the interior of shops. The diagram shown in Fig. 11 gives the frequency of occurrence of bare lamps, diffusing and prismatic reflectors, semi-indirect bowls and totally enclosed units. Butchers and tobacconists head the list of the trades under consideration regarding the use of bare lamps, while boot shops, tailors and jewellers have fewest. Drapers and boot shops use more semi-indirect fittings than the other trades, while in general there is a greater preponderance of diffusing and prismatic reflectors. It is significant that jewellers use very few semi-indirect bowl-fittings, and chiefly employ direct lighting equipment, either totally enclosed units or diffusing and prismatic reflectors. Without doubt this is due to the fact that direct methods of illumination give a glitter and sparkle to jewellery that cannot be obtained by semi-indirect and totally indirect methods of lighting.

LIGHTING OF SHOPWINDOWS

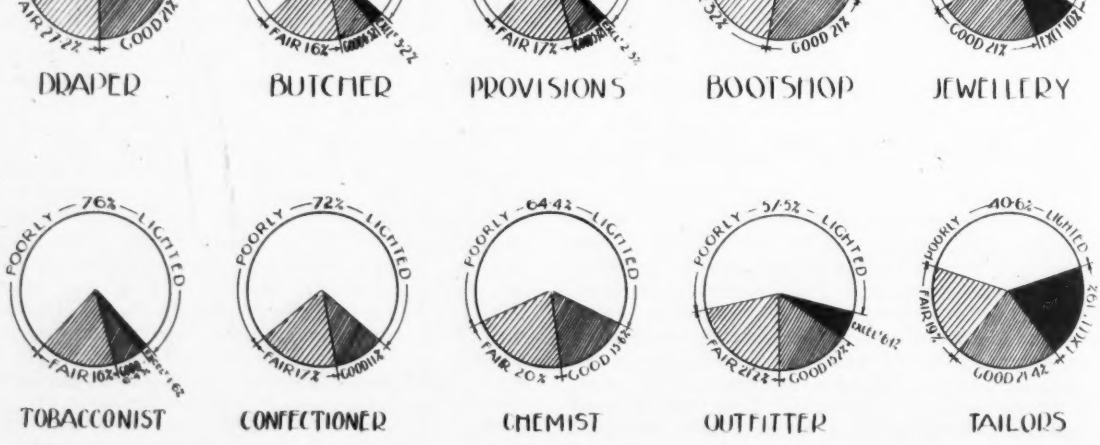


FIG. 8.

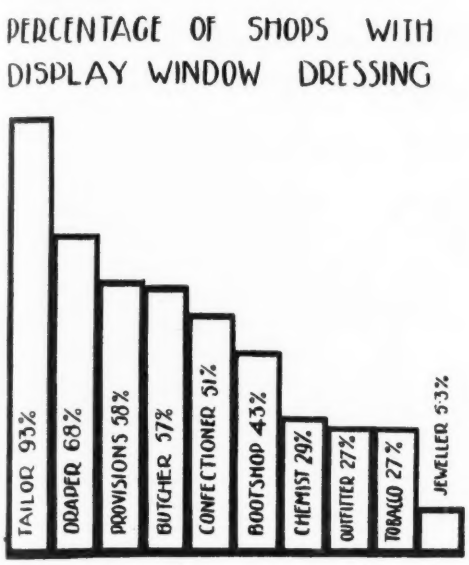


FIG. 10.

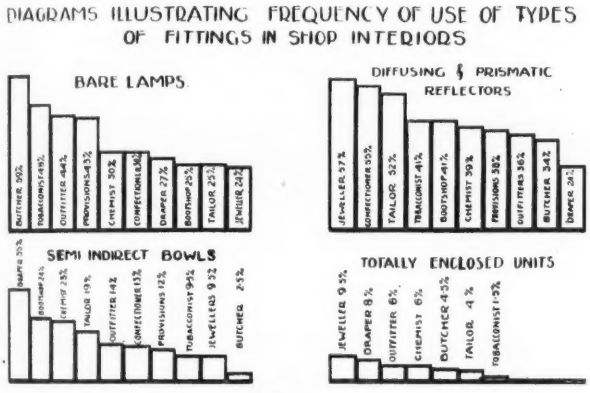

DIAGRAMS ILLUSTRATING FREQUENCY OF USE OF TYPES OF FITTINGS IN SHOP INTERIORS
BARE LAMPS
DIFFUSING & PRISMATIC REFLECTORS
SEMI INDIRECT BOWLS
TOTALLY ENCLOSED UNITS

FIG. 11.

It will already have been noticed that consideration has been given to shops where there are fittings and lamps immediately over the counter, and Fig. 12 illustrates the dependence of the shop upon general lighting only and not upon these local lamps. As one would expect, the boot shops, drapers and tailors head the list, while confectioners and jewellers, who usually have a number of drop pendants immediately over the counter, are last.

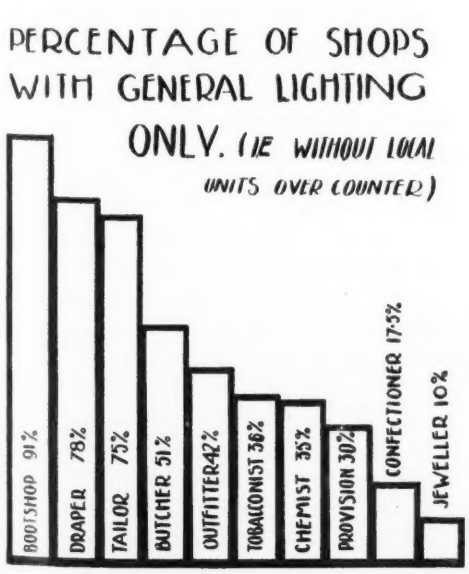


FIG. 12.

Illumination.

Table II gives values of watts per foot run of window, watts per square foot of interior, and some data regarding the illumination at the counter. It will be noticed that a high proportion of the shops have less than 5 foot-candles intensity on the counter, and between 50 and 60 per cent., almost regardless of the nature of the business, have between 5 and 10 foot-candles. There is a noticeable difference, however, when we are considering the percentages of shops employing 10 foot-candles. Tobacconists and drapers seldom employ this intensity, whereas with tailors, chemists and butchers this value is quite often found, and is in many cases exceeded.

TABLE II.

Type.	Watts per ft. run.	Watts per sq. foot.	Max. ft.-c.	Min. ft.-c.	Under 5 ft.-c. %	5-10 ft.-c. %	Over 10 ft.-c. %
Tobacconist	32·5	1·29	14·5	2·75	50	45	5
Confectioner ...	35	1·35	18·75	3·75	42	52·8	5·2
Chemist	39·5	1·32	14·5	2·75	45	36	19
Outfitter	43	1·2	17·5	2·5	30	58	12
Tailor	72·5	1·6	19	2·2	30·4	44	25·6
Draper	49	1·6	13·2	2·8	35	60	5
Butcher	34·2	1·4	13	2·2	23·2	61·5	15·3
Provisions	32	1·5	20·2	2	30·7	57·8	11·5
Boots	63	1·07	22·5	2·2	43	49·4	7·6
Jewellers	50	2	13·5	3	26	58	16

It is felt that the above information will meet a long-felt need and enable not only the trades concerned, but also engineers, to judge the progress which is being made in lighting. A similar survey made at some future date would readily indicate any advance. In conclusion the authors desire to mention that the investigators on the survey were frequently questioned by the shopkeepers regarding methods of improving their lighting conditions, and apparently were most anxious to do all they could in this direction.

We desire to express our appreciation to Messrs. E. S. Evans and R. C. Hawkins, of the Lighting Service Bureau of the Electric Lamp Manufacturers' Association, for the painstaking way in which they have carried out the field work of this survey.

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[The paper was illustrated by a representative series of exhibits of modern shop lighting appliances. An interesting discussion ensued in which the following took part: Mr. L. Gaster, Mr. A. Gabriel, Mr. E. Stroud, Mr. W. Millner, Mr. J. M. Waldram, Captain W. J. Liberty, Mr. R. A. Lower, Mr. W. E. Bush, Mr. E. S. Evans, Mr. R. C. Hawkins, Mr. G. Herbert, Mr. Goldman, Mr. C. Hughes, Mr. Morton, Mr. W. G. Raffé and Mr. C. H. Merz. After Mr. W. J. Jones and Mr. H. Lingard had briefly replied to the discussion, votes of thanks to the authors, to Mr. Sully for presiding, and to the E.L.M.A. Lighting Service Bureau for their hospitality terminated the proceedings. We propose to summarize the discussion in our next issue.—ED.]

The Mutochrome

A Novel Instrument for the Design and Projection of Coloured Patterns

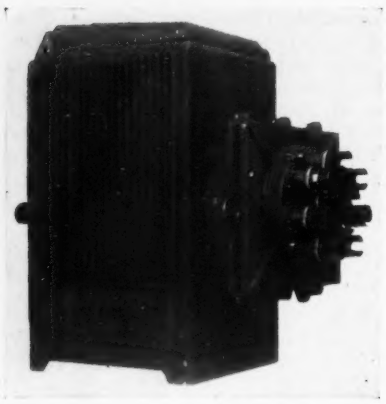


FIG. 1.—General view.

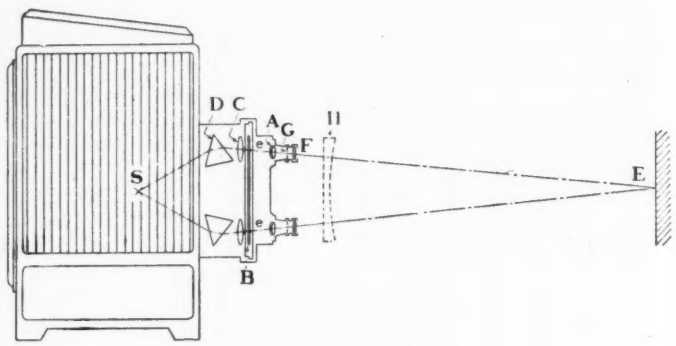


FIG. 2.—Diagrammatic view, showing details.

THOSE who were fortunate in being present at the lecture given by Mr. L. C. Martin at the Polytechnic on May 6th were rewarded by various interesting experiments in colour, including the "Mutochrome" apparatus, which is the invention of Mr. C. F. Smith, of the technical staff of Messrs. Adam Hilger, Ltd. Through the courtesy of the Chromoscope Co., Ltd., the writer had recently an opportunity of seeing this apparatus in operation, and it occurred to him that a brief account of it would be of interest.

The instrument is essentially an apparatus for the study of the coloration of decorative designs. Its general appearance is shown in Fig. 1, the details in Fig. 2. The colour combinations are effected by juxtaposing the chromatic components of a design, which are projected simultaneously on to a screen (which may, for instance, be the material on which the pattern is ultimately to be printed). The component images are projected through a series of objectives and colour filters, and the optical system includes the prisms D, the series of condensers C, and, if desired, the enlarging concave lens H. By means of iris diaphragms on the objectives the luminosity of any individual portion of the design can be altered; thus marvellous changes in the colouration of the pattern may be produced.

This explanation gives an idea how the pictures are *projected*. It is next necessary to explain how they are prepared prior to projection. It is here that the ingenuity of the apparatus, which can serve either as a projector or a camera, becomes manifest. Stencils are made of the individual patterns in black and white, and in turn are placed in accurate alignment on the screen. A photograph of each is taken in succession on the photographic plate B. Then, when the instrument is used as a projector, all these photographs are automatically reproduced on the screen in their correct positions, forming the complete whole.

The apparatus is intended to be useful to all industries concerned with coloured patterns, whether wall-papers, printed fabrics, etc. By altering the colour filters and modifying the intensity of light almost any combination may be obtained. A number of people can inspect the picture simultaneously, and the agreed design coloured as desired before their eyes. By taking note of the stops on the lenses and the numbers of the colour filters, it is also possible to convey information to a distance, so that anyone possessing a "Mutochrome" can build up the pattern in facsimile. The projecting source is merely a 400 or 1,000 watt gasfilled projector lamp, with special bunched filament, which can be run on 100-260 volts.

In a larger form the apparatus can also be used for the projection and building up of scenery on the stage, and we understand that developments in this direction are proceeding. This process of painting with coloured light should be of great value in the modern theatre, as colours in the design can be altered at will, or an entirely new scene built up and substituted quite expeditiously.

The apparatus is also adapted to the demonstration of many familiar colour effects. Thus the phenomena of simultaneous contrast, the Purkinje effect, and mixtures of coloured light can be studied. Specially striking is the effect when a painted scene is illuminated successively by different forms of coloured light—a device which has already been used on the stage in the form of a giant spectroscope devised by Major Adrian Klein, and recently described before the Illuminating Engineering Society.

Isocandles and the Assymetric Lighting Unit

In the *General Electric Review* (U.S.A.) for April, Mr. F. A. Benford raises an interesting point—the unsuitability of ordinary polar curves of light distribution for many purposes, especially when "assymetric" units are concerned. Accordingly he has devised a new method based on the use of "isocandle lines," i.e., lines of equal intensity in candles, plotted on a web, which is in effect a flattened-out hemisphere, simple for reproduction on paper. A series of such diagrams, representing distribution of candle-power in a street, are reproduced. In appearance they are not unlike the contour lines of illumination, of which Mr. Trotter made a special study, but it must be remembered that they represent *equal candle-power*. One incidental advantage of the method is that it gives a better picture of the total flux emitted by a unit. As is well known, the ordinary polar curve is apt to be misconstrued in this respect, as units giving the same flux of light but different distribution may have polar curves of widely different area.

Lectures on Illuminating Engineering

(Under the Joint Auspices of the Illuminating Engineering Society and the Electrical Engineering Dept. of the Polytechnic [Regent St.])

THE series of lectures on Illuminating Engineering at the Polytechnic (Regent Street) was continued on Monday, April 27th, when a lecture on "Progress in Electric Lighting" was delivered by Mr. B. P. Dudding (of the G.E.C. Research Laboratory).

Progress in Electric Lighting.

Mr. B. P. Dudding (G.E.C. Research Laboratory), in his lecture on the above subject on April 27th, commenced by a brief historical review, pointing out that some of the very earliest researches on incandescent lamps utilized metal, such as platinum, for the filament, though this was superseded by the carbon filaments evolved by Swan in this country and Edison in the United States. By the aid of diagrams showing the distribution of energy in the spectrum of an incandescent body at various temperatures, the lecturer showed how small is the proportion of such energy that falls within the visible spectrum. With rising temperature of incandescence this proportion is substantially increased; hence the higher efficiency of the latest forms of metal filament lamps. "Selective radiation" also plays some part in increasing efficiency, but in practice the choice of materials for filaments is determined primarily by capacity to withstand high temperatures rather than selective properties.

Mr. Dudding then proceeded to make a general survey of developments in electric incandescent lamps from the carbon filament onwards. He dealt briefly with the Nernst, osmium and iridium and tantalum filaments, and mentioned the "Helion" filament, utilizing a combination of carbon and silicon, as a promising attempt, which might have had important results but for the development of the tungsten filament which is now embodied in all commercial electric incandescent lamps.

The use of the tungsten filament, first in vacuum lamps and next in gasfilled lamps, was discussed in some detail. The preparation of ductile tungsten from the ore was briefly described, and the important part played by spiralizing in the gasfilled lamp explained. The lecturer also showed, by the aid of diagrams, how the presence of an inert gas enables the filament to be run at a materially higher temperature without undue disintegration, and how the use of a filament of larger superficial area, obtained by spiralizing, diminishes the energy carried away by the gaseous envelope and is instrumental in solving the problem of producing an efficient gasfilled lamp. These successive advances were illustrated in a table showing how the original specific consumption of the carbon filament lamp in 1903, 4·5 to 5 watts per candle, had been reduced to only 0·7 to 1 watt per candle (mean spherical) in the larger types of gasfilled lamps of to-day.

The final section of the lecture was devoted to some interesting information on the structure of the tungsten filament in relation to life and durability, and was illustrated by many striking micro-photographs. It was explained how ordinary tungsten filaments, containing rather less than 0·1 per cent. of impurities, consist of fine grains, which, in the early stages of life grew together until they occupy the full cross-section of the wire. The sagging and drooping of filaments of gasfilled lamps, which is one of the main causes of fall in candle-power and efficiency, is associated with this grain growth. But the presence of small amounts of certain refractory oxides, such as thoria, causes the rate of grain-growth to be much reduced, and the performances of "thoriated" tungsten filaments are correspondingly improved. Another line of the development has been the introduction of minute percentages of salts of the alkalis, which have the opposite effect, i.e., grain-growth takes place with extraordinary rapidity, so that, in a few seconds after the filament has been brought to incandescence, it consists of only a few long crystals throughout its entire length. Such a filament is quite stable during life, and no appreciable deformation occurs.

The lecture also included an illustrated account of the various stages of manufacture of an incandescent lamp, and was much appreciated by the audience.

The next lecture, by Mr. J. G. Clark (of the Gas, Light and Coke Co.), on Wednesday, April 29th, dealt with gas lighting, and was illustrated by a comprehensive series of exhibits of modern gas lamps, globes, shades and reflectors and methods of distant control.

Progress in Gas Lighting.

Mr. Clark said that his remarks could be no more than an introduction to the very large subject of gas lighting, but that anyone needing further information could obtain it by communicating with the British Commercial Gas Association, whose literature was presented to those in attendance.

A brief survey was then made on the progress of gas lighting from the earliest times to the present day. A significant fact was that the lighting was in every case due to incandescent solids, namely, carbon in the case of the flat flame, argand and luminous flame burners, and the mantle in the case of modern gas lighting. Brief reference was made to Welsbach's work, the thoroughness of which was shown by the fact that the chemical composition of the mantles of the present day was practically identical with the composition determined by Welsbach, namely, 99 per cent. thoria and 1 per cent. ceria.

Nevertheless, great progress in mantle manufacture had been made and, as a result, the modern product, whilst being immensely stronger than the earlier mantles, could be purchased at only a fraction of the cost.

Methods of testing mantles were described, and large purchasers of these articles were advised to govern their purchases by means of one or other of the tests suggested. The tests comprised a determination of the lighting properties of the mantle together with its strength and degree of shrinkage. It was pointed out that shrinkage should be practically nothing.

In alluding to the efficiency of gas lighting, Mr. Clark said that seeing that nearly all the lighting produced in this country was produced through the agency of coal it was important to consider the efficiency of utilization from the national point of view. He said that gas was amongst the foremost illuminants in this respect, that is, the conversion of the heat energy of coal into light. Efficiency was then considered from the consumers' point of view—the number of therms necessary to produce a given number of candle-hours. It was shown that in the modern low-pressure cluster type of inverted burner one candle-hour can be produced with only half the number of B.Th.U.'s required in the upright incandescent burner; and in the high-pressure inverted lamp the number of B.Th.U.'s required was still fewer. The reasons for this difference in efficiency were considered. Preheating of the Bunsen mixture before combustion, and the high aeration of the mixture by compression of the gas were suggested as the principal factors.

One result of these various methods of employing gas for lighting was the production of units ranging from 25 to 5,000 candle-power.

The disadvantages of using cheap burners such as can be produced at small shops was alluded to. Owing to the bad design and workmanship they give only a poor efficiency. In an endeavour to discourage the use of these inefficient fittings several makes of burner had been recently introduced into the gas industry by firms of repute. These burners are well designed, though very

simple in construction, and can be supplied to consumers at very low prices. As light units they are comparable with the best types of burners that can be obtained, and therefore ensure to the consumer the efficient use of his gas. Amongst the many good features of these burners is the facility offered for interchanging the nozzle. It is possible to put a small nozzle on a larger burner, thereby reducing its gas consumption and candle-power and also avoiding the necessity for purchasing an entirely new burner.

The use of glass and silica ware for diffusing light was then alluded to. Silica, owing to its special refractory properties, can be used very close to an incandescent mantle, thereby conserving the temperature of the mantle and raising its incandescence.

The importance of using the proper reflecting shades was mentioned, and in a number of illustrations it was shown that suitable reflecting shades could be provided with modern gas units. The importance of this in relation to factory lighting was illustrated.

The growing popularity of the semi-indirect system of lighting was mentioned, and some units for use in this way were available for inspection.

By means of illustrations Mr. Clark was able to allude to various aspects of gas lighting, including the lighting of streets, railway stations, factories, schools, churches, etc. Also, he had available for demonstration the group system and flood-lighting system of Messrs. James Keith and Blackman, Ltd.

In conclusion, Mr. Clark made reference to the different systems of control in relation to gas equipment. He showed how gas lamps in an inaccessible position could be easily controlled by various means. The automatic lighting and extinguishing of street lamps was also illustrated.

Daylight Illumination.

The next lecture, by Mr. P. J. Waldram, dealt with "Daylight Illumination." After pointing out the different sources of daylight illumination, comprising the sun, the blue sky and the diffused light from a white sky, the lecturer pointed out the enormous variations met with in practice. Diagrams were exhibited showing how daylight varies throughout the seasons, and at different times during the day. It was remarked that the unaided eye is unable to detect very large fluctuations in daylight, after a certain intensity has been attained. Hence the need for the illumination photometer in order to determine what actually occurs.

It was shown in general terms how Lambert's Law may be applied to daylight illumination, and the illumination on a horizontal or vertical plane computed. The discussion of daily and seasonal changes in daylight led to an explanation of the "daylight ratio," i.e., the ratio between the full illumination from an obstructed sky and the actual illumination at a certain spot in a room. This constant should be practically independent of periodic natural fluctuations in daylight; it depends primarily on the relation of window space to dimensions of a room and on the effect of outside obstructions (trees, buildings, etc.), and may therefore be taken as a good indication of "access of daylight" into a room. In particular, determinations of the daylight factor prove of value in determining how access of daylight is affected in "ancient light" cases.

Mr. Waldram next showed how a window, more or less occupied by white sky, may be treated as a lamp, and how the resultant illumination inside a room can be estimated and graphically represented. Diagrams illustrated how the light derived from the upper region of the window is of special value for the illumination of interiors. By such methods, aided by data on periodic fluctuations in daylight intensity, daylight conditions in a building can be predetermined with fair exactitude before its erection.

In conclusion, a few remarks were made upon the nature of artificial daylight and the means by which the colour of normal daylight can be imitated. Here again the nature of daylight to be reproduced needs consideration, as material differences exist between the quality of light furnished respectively by direct sunlight, skylight, and light from a diffused white sky.

Colour in Illuminating Engineering.

Mr. L. C. Martin (of the Imperial College of Science and Technology) dealt with the above subject in his lecture on May 6th.

In some introductory remarks on colour vision the lecturer pointed out that the power of distinguishing hue is one of the most valuable properties of vision, both from the utilitarian and æsthetic standpoints. Since illumination is, first and last, an aid to vision, the correct rendering of colours is of the first importance. Other scientific aspects of the question discussed included the colour-characteristics of various sources, the reflecting power of coloured materials, the production of coloured light for scenic and similar purposes, etc. Æsthetic considerations have also to be taken into consideration.

Turning next to the effect of lights of different colours, Mr. Martin showed how the projection of a spectrum enables the reflecting and transmitting powers of various materials in different parts of the spectrum to be studied. The hues which these materials exhibit in white light are due to selection, reflection, and transmission. The problem has been studied quantitatively. Magical effects of disappearing scenery are possible when coloured designs are illuminated with monochromatic light. A mercury-vapour lamp is unsuitable as an illuminant when correct revelation of colours is desired, because of the discontinuous nature of the spectrum, which causes unduly strong selective effects. Illuminants for general practical use should possess fairly continuous spectra, such as those given by incandescent bodies. This property must be taken into consideration besides the ordinary basis of luminous efficiency, i.e., the amount of light rendered per unit of energy. Adequate hue discrimination it was remarked, even with a suitable source demands an illumination of about 4 foot-candles. If rooms are to be generally lighted the reflection coefficients of the walls should be studied. Light walls are favourable to economy of light, whereas the use of highly saturated colours on walls may prejudice the colour-efficiency of a system.

The above remarks led up to an account of the development and uses of artificial daylight. These artificial daylight units remove the excess energy of the longer wavelengths from artificial illuminants by filters or reflectors. The luminous efficiency is inevitably low, and some of the violet in the spectrum is absent, but the units have proved to give sufficient accuracy for practical purposes, and they have many applications, for example, in picture galleries.

The problem of the production of coloured light was next discussed. There is now available a wide range of light-filters and reflectors, which have been the subject of photometric study. Large monochromators are used for special purposes, and such appliances find many applications in decorative and stage lighting. One of the latest instruments for the study of colour-lighting problems, exhibited by the lecturer, is the "mutachrome," which projects eight or more interlaced parts of a single design in true registration to form the whole. Colour-filters in each projector are used to vary the colour of the image in any section of the design. This apparatus is the recent invention of Mr. C. T. Smith, and is capable of wide application in the production of tasteful colour contrasts, and in the study of novel stage effects. It can also be used for the projection of scenery in a theatre.

In conclusion, the author discussed in some detail the psychological effects of colour, which have been the subject of study by Titchener, Pressey, Troland, and others. The association effects of colours are important. The stimulating effects of the warm colours and the sedative effects of the cold are well established in experience, but theorists differ in detail.

The lecture was illustrated by many interesting experiments, and thanks were expressed to, amongst others, the Sheringham Daylight Development Co., Ltd., and the Cromoscope Co., Ltd.

Principles of Good Lighting in Home, School and Offices.

On May 11th, Mr. P. Kemp (Electrical Engineering Department, The Polytechnic), gave a lecture on the above subject. He pointed out that the modern idea of illumination includes a general increase in all-round illumination, adequate diffusion and uniform distribution of the light, absence of glare and shadows, and an approximation to daylight conditions as far as possible. The realization of these conditions means less eyestrain and physical fatigue, greater output, and a more pleasing appearance.

The distribution of illumination is dependent upon the polar curve of the lamp itself and upon the type of reflector or diffuser employed. Almost any desired distribution of illumination can be obtained by suitably designing the reflector.

This led to a consideration of shades and reflectors. The objects of shades, reflectors, etc., are (1) the saving of artificial light by sending it in the desired direction, and thus preventing it from falling on surfaces having high absorption factors and where a relatively small amount of light is needed; (2) the diffusing and dispersing of the light rays, thus making it easy to work by; and (3) the reduction of the light absorption to a minimum, thus ensuring a maximum economy.

Reflection may be divided into three kinds: (1) specular or regular reflection, as is obtained with mirrored glass; (2) spread reflection, as on polished wood; and (3) diffuse reflection, as on matt surfaces.

Refraction in shades is made use of for obtaining a soft effect, as is also diffusion.

Absorption represents loss. When light rays strike a body they are resolved into three parts, viz., reflected, transmitted and absorbed. The absorption per cent. varies from 5 to 12 with clear glass, to from 10 to 20 with a light sand-blast, and to 15 to 30 with ribbed glass.

Mr. Kemp pointed out that the distribution curve is extremely useful in indicating the characteristics of a particular lighting unit, but it does not directly indicate the total amount of light emitted. A given candle-power in directions approximately to the horizontal give rise to many more lumens than the same candle-power in a vertical direction. In comparing distribution curves this should be borne in mind.

Practically any shape of distribution curve can be obtained by suitably designing the reflector, but for most interior purposes one of three types of reflectors will be found suitable. These are, respectively, the extensive, intensive and focussing types. In spacing a number of lighting units over a room, such as an office or a classroom, the working plane is divided into a number of squares, and the height of the lamps must be considered amongst other factors. The ratio of the height of the lamps to the size of the square determines the type of reflector to be used. With lamps arranged in the above manner for massed clerical staff, an even distribution of three foot-candles over the working plane is satisfactory, but for typists an illumination of six foot-candles on the manuscript is not excessive.

There are three general systems of illumination in vogue, viz., direct, semi-indirect, and indirect. In direct lighting the larger part of the light is thrown directly on to the working plane. In semi-indirect lighting a translucent bowl throws most of the light up to the ceiling, part being diffused through the bowl. With indirect lighting an opaque reflector is used, and the ceiling must have good reflecting qualities.

Finally the lecturer illustrated the application of such methods to practical problems. In domestic lighting the problem is complicated by the artistic effect desired. Drawing-room lighting should be either indirect or semi-indirect, with local lighting for special purposes if desired. Properly shaded direct lighting is satisfactory in dining-rooms. The best effect in bedrooms is obtained with general illumination and local lighting for the dressing-table. It is a mistake to underlight the kitchen.

Various other examples of lighting were illustrated and discussed.

Hygienic, Economic and Legislative Aspects of Industrial Lighting

IN his lecture on the above subject Mr. L. Gaster pointed out that good lighting in factories is now regarded as an indispensable item, of equal importance to proper heating, ventilation and sanitary conditions. Recent investigations of Dr. Oblath showed how intimately lighting is associated with the eyesight of workers; cases were quoted in which derangements of eyesight were found to be much relieved when better lighting was introduced; miners' nystagmus, a special disease of the eyes, is now generally recognized as being due primarily to inadequate lighting conditions in mines.

Apart from its direct effect on the eyes inadequate lighting is prejudicial to general health. Conditions in a modern factory are quite different from those prevailing before the "industrial era." Much greater accuracy and speed are demanded than in the old days, and workers are liable to industrial fatigue, which is accentuated by inadequate illumination. Similarly inadequate lighting is responsible for many industrial accidents. Diagrams were shown illustrating how accidents are most frequent during the short winter days when artificial light is mainly used; this applies particularly to "accidents due to persons falling," a class that is evidently particularly apt to be caused by bad lighting conditions. A bad accident, besides putting a useful worker out of action, upsets the routine of a factory for a considerable time afterwards. Hence good lighting is desirable on economic as well as humanitarian grounds.

The economic aspects of better lighting were further illustrated by reference to recent tests on the relation between conditions of illumination and production. Tests conducted in the United States had shown increases in output up to 30 per cent. when better lighting was installed, and the proportion of spoiled work was less. Similar evidence was afforded by the investigation into the lighting of post offices, undertaken by the United States Health Department. In most cases lighting costs formed only a very small proportion—frequently not more than 1 per cent.—of the costs of production. Hence the cost of better lighting was quickly repaid by improved efficiency of work.

These remarks led to an analysis of the main requirements of good lighting, as stated in the Reports of the Home Office Departmental Committee on Lighting in Factories and Workshops. The recommendations in regard to avoidance of glare, troublesome shadows and sufficient illumination were explained, and it was shown that these were in general agreement with the codes introduced in the United States and with recommendations made by the Illuminating Engineering Society in Germany.

Mr. Gaster emphasized the fact that any legislative action must be based on considerations of the health and safety of workers, should not involve hardship and should be willingly accepted by employers and workers in their common interest. Accordingly the Home Office Committee suggest legal minima for working illumination, but only recommended 3 foot-candles for fine work and 5 foot-candles for very fine work, as a guide to working practice. Each factory presented special problems and the Home Office had invited the co-operation of joint industrial councils in order to determine the requirements of the various industries concerned. Illumination had now become a subject of international importance, as illustrated by the attention paid to the matter at the recent meetings of the International Illuminating Commission and of the first Congress on Industrial Hygiene, held in Geneva; the International Labour Department of the League of Nations, located in the same city, was likewise studying these problems in detail.

Recommendations on Illumination

Issued by the Illuminating Engineering Society in Germany

(Slightly Abbreviated.)

[*Issued by the Illuminating Engineering Society in Germany in co-operation with the Reichs-Arbeitsministerim (Ministry of Works), Preussische Ministerium für Handel und Gewerbe (Ministry of Trade and Labour), Polizeipräsidium (Commissioner of Police), Ausschuss für witschaftliche Fertigung (Council for Economic Production), Verband der Elektro-Installateure (Union of Electrical Contractors)*].

(Concluded from page 97, April, 1925.)

III—Recommendations on the Lighting of Factories and other workplaces

FOR all forms of workshops the question of illumination is of extreme importance.

Good illumination is essential for regular and efficient working.

Bad illumination diminishes efficiency, is prejudicial to supervision, order and cleanliness, and is injurious to the health of the worker and liable to cause accidents. Good illumination need not be more expensive than bad lighting—it is often even less costly both as regards initial outlay and running costs, and soon pays for itself.

The following considerations apply to all factories, but are primarily concerned with artificial light.*

Recommendations.

(I) The lighting installation must correspond with requirements in the interest of freedom from danger, health and reliability.

(II) The illumination must be adequate.

Recommendations in regard to adequacy of illumination are assembled in the accompanying table. The figures in the first column represent the *average* illumination that should be provided; those in the second column the *minimum* illumination that should be tolerated at the respective points of work.

Nature of Illumination.	Illumination (Lux) Average.	Minimum.
Illumination necessary for traffic:—†		
Roads, yards, etc., serving for traffic	0·5— 2	0·2
Passages, storerooms, etc.	2 — 5	0·6
Entrances and exits, main corridors, stairs and workshops	5 — 15	2
Working illumination:—		
Rough work, e.g., in rolling mills, forges, rough assembly, etc. ...	15 — 30	10
Medium work, e.g., turning, assembly, joinery, locksmith's work, tinwork, spinning and weaving with light yarn ...	40 — 60	20
Fine work, e.g., fine metal work, office work, weaving with coloured or dark yarn	60 — 90	30
Very fine work, e.g., watchmaking, engraving, composition of type, needlework, in drawing offices, etc.	90 —250	50

Illumination necessary for traffic to be measured in an horizontal plane one metre above the floor; working illumination likewise, or on the actual surface where work is done. (The average illumination is to be determined from a sufficient number of measurements uniformly distributed over the entire area under consideration.)

(III) The illumination shall not give rise to glare.

The following conditions are regarded as causing glare:—

(1) *General Illumination.* Sources which have a brightness exceeding 5 candles (Hefner) per sq. cm. falling within the direct range of vision. (Lamps mounted at such a height that the angle between the horizontal plane and a line drawn from the eye to the source exceeds 30° may have a higher brightness without being regarded as liable to cause glare.)

(2) *Local Illumination.* Sources having a brightness exceeding 0·75 candles (Hefner) per sq. cm. and falling within the direct range of vision.

(3) *For all forms of Illumination.* Bright surfaces which, owing to polish, reflect light into the eyes of workers, thus causing disturbance to vision.

(IV) The illumination should not involve any troublesome sharp shadows, and should not be subject to marked *lack of uniformity* nor *flicker*. Attention should be paid both to proper distribution of light and to ensuring that light comes from the right direction.

Explanations of Recommendations and Practical Hints.

I. Attention to safety, health and reliability.

In circumstances where danger of fire or explosion exists owing to accumulation of light combustible dust in the atmosphere, or inflammable gases, etc., suitable precautions should be taken. Recommendations on this subject have been made by the Verband Deutscher Elektrotechniker and its associated bodies.

If the heat from illuminants or products of combustion are liable to give trouble, attention must be given to the provision of ventilation.

Consideration should always be paid to the question whether, and to what extent, independent emergency lighting should be provided in addition to the ordinary methods of illumination. (See recommendations issued by the Verband Deutscher Elektrotechniker.)

II. The illumination must be adequate.

(1) *Explanation.* The values given in the first column in the above table relate to average illumination over the space where traffic takes place or in a room, measured at a height of one metre above the floor (on the working surface).

Values in second column relate to the minimum illumination in similar circumstances. The illumination on any spot free from deep shadow should not, in the interests of convenience and safety, fall below these assigned values (e.g., owing to dirty windows, lamps, reflectors, etc.).

In the interests of efficient operation and accuracy of work considerably higher illuminations may be recommended. For daylight a multiple of the values given in the first column is, in general, desirable.

(2) *Practical Hints.*

(a) *Illumination and perception.*

Power of perception is not directly proportional to the illumination, but at first (with weak illuminations) increases very rapidly, and afterwards more slowly. In artificial illumination it is seldom necessary to exceed 250 lux.

Power of perception is also dependent upon contrast (e.g., black and white, etc.), and on the amount of light entering the eye, hence also on the coefficient of reflection of the material. Dark materials reflect less than light ones; hence, in the case of dark stuffs, one must use an illumination considerably higher (up to ten times as much) than is the case with light material.

(b) *Local or general lighting.*

The working illumination may consist of either local or general illumination.

* An extension to natural illumination is now being prepared.

† This term (in the original *Verkehrsbeleuchtung*) is understood to include illumination for the purpose of facilitating movements of persons and objects.

Local illumination is effected by means of sources mounted at a low level, each intended to illuminate a restricted area of work; supplementary weak general illumination, for general convenience, is then also necessary.

General illumination is effected by lamps mounted at a high level, by which the room as a whole is lighted.

The choice between these two methods depends on the nature of the work and the proximity of workers.

For local illumination lamps with deep reflectors, within which the source is completely screened, should be selected, both as a protection against glare and in order to direct all, or at any rate the greater part of, the light on to the working area. Such local units should, in general, be adjustable.

Bare lamps or lamps with shallow reflectors are unadapted for local lighting; they cause glare and waste the light, which is not concentrated on the workplace.

With general lighting one utilizes relatively few lamps of high candle-power. The cost of installation is cheap, and as the high candle-power lamps are considerably more efficient than those of low candle-power, running costs are in general not more expensive, and indeed often cheaper, than when local lighting is used. Hence the tendency is towards wider use of general illumination.

(c) *Maintenance of illumination.*

Accumulations of dust on globes, reflectors, walls and ceiling, window, skylights, etc., may diminish the illumination by 50 per cent. or more. Hence regular and periodic cleaning of lighting appliances, windows, walls and ceilings should be arranged.

A correct pressure for electrical lamps is of importance. At too high a voltage they soon burn out, at too low a voltage they give materially less light and are inefficient.

Gas lamps will only burn efficiently and silently when properly adjusted.

In any case available illumination is considerably increased and improved by the presence of light walls and ceiling. One should therefore aim at providing, wherever possible, a white ceiling and broad white frieze and see that both are repainted from time to time. Similarly, bright window-blinds having a high reflection factor are also useful.

(d) *Measurements of illumination.*

The determination of intensity of illumination requires an illumination-photometer. There are now available cheap, reliable and portable instruments, the use of which can be entrusted to those who are not experts. In the case of large installations the study and control of illumination is well repaid.

III. The conditions of illumination should not give rise to glare.

(1) *Nature and effects of glare.*

Glare is a disturbance of power of perception arising from excessive light falling on the retina. It is prejudicial to power of perception, safety and comfort; in the case of long and severe exposure it may even cause injury to the eyes.

Glare involves waste of light; for when the powers of vision are diminished the illumination is not fully utilized.

Experience shows that glare is often a cause of accidents, besides, when excessive and of long duration, being injurious to the eyes and health of workers.

Glare must therefore in all cases be avoided. It forms the chief defect in many lighting installations, yet this is often not recognized; people blame the lack of light, install more powerful lamps, and thus make the conditions even worse.

(2) *Detection of glare.*

If one looks fixedly at objects adjacent to the place of work, and then screens the eyes from the sources of light with the hand, and then observes that the objects viewed appear appreciably clearer, it may be assumed that glare is present. (Repetition of the process of screening and uncovering the eyes is recommended.)

(3) *Origin of direct glare.*

Glare arises when sources of great brightness emit light into the eyes of workers. The greater the brightness of the sources the more severe the effect; further, the glare is accentuated, the greater the candle-power in the direction of vision; the nearer the light source to the eye, the more directly the source falls within the normal range of vision, and the darker the background against which the sources are viewed.

Sources with a brightness of 0·75 candles (Hefner) per sq. cm. and less (candles, oil lamps, etc.) in general cause little or no glare. This degree of brightness is therefore prescribed as the limit for lamps used for local lighting. Since other sources ordinarily used (incandescent mantles and electric glow lamps) have a materially higher brightness, these should not be used in an unscreened condition for local lighting. Also, in such circumstances, the frosting of lamp-bulbs does not suffice to eliminate glare completely.

Lamps for general lighting are further removed from the eye and are less liable to fall within the direct range of vision. Hence they may have a brightness up to 5 candles (Hefner) per sq. cm. Moreover, when they are mounted so high that the angle between an horizontal plane and a line drawn from the eye to the source exceeds 30°, such lamps may have a still higher brightness. Lamps hung very high indeed may have any brightness without limit.

(4) *Means of avoiding glare.*

(a) *Screening of the source by opaque material (reflectors).*

In the case of local lighting reflectors must comply with two requirements. Firstly the eye must be completely protected against glare, and secondly all or most of the light should be directed on the place of work. Flat or shallow conical reflectors do not comply with these requirements, only deep reflectors, within which the source is completely concealed.

(b) *Screening of lamp by translucent and diffusing bowls, plates, etc.*

Frosted glass in general diffuses the light but little and also (unless very heavy) diminishes the brightness of the source but little. Unscreened frosted glow-lamps are in general to be regarded as glaring if used for local lighting. Good diffusing materials are opal, and similar glasses and translucent shades. It is recommended that skylights should be whitened during the summer as a precaution against glare from direct sunlight.

(c) *General lighting with lamps arranged outside the normal range of vision* (i.e., in positions such that the angle between the horizontal plane and a line drawn from the eye to the source is not less than 30°). In these circumstances the eye, when directed downwards is protected from glare by the eyebrow. The greater the angle with the horizontal at which the light comes, the better the protection against glare.

(5) *Indirect glare.*

Origin of glare:—

Glare may also be caused indirectly when the ray of light coming from a bright and polished surface is directly reflected into the eyes of the worker. Bright metal, polished surfaces, sheets of glass, glazed writing paper, writing with pencil (and especially copying pencil) may exhibit glare of this kind, which may be disturbing to operators.

Means of protection:—

(a) The trouble only arises when light-source and eye lie in a vertical plane and the angles formed with the surface by the incident ray from the source, and the ray from the surface to the eye are identical. Hence the inconvenience can usually be avoided by arranging the respective positions of light-source, reflecting surface and eye so that the reflected rays do not strike the eye (e.g., if the lamp is not directly opposite the worker but somewhat to the side).

(b) Conditions are also improved if the brightness of the light-source can be diminished.

IV. No troublesome shadows; no fatiguing contrast in brightness nor flicker; good light-distribution; correct direction of light.

(1) *Sharp shadows.*

Sharp shadows become troublesome when they endanger safety of movement of operators. They are to be avoided by correct position and choice of lamps and lighting accessories.

(a) *Positions of lamps.*

Lamps should be so arranged that no sharp shadows are cast on working areas nor on places where there is much traffic (e.g., on a step in the floor-surface, or stairs, on important parts of machines, handles, etc.).

(b) *Choice of lamps and accessories.*

The more the light-source approaches to a point and the darker the background the sharper the shadow. The more extensive the surface from which light comes (e.g., illuminated ceilings) and the more the direct light falling on the working area is subjected to screening (semi-indirect or indirect lighting) the less distinct the shadow. Similarly, the more light received and reflected from surfaces adjacent to lamps serving for the direct lighting, the stronger are shadows illuminated and diminished in sharpness.

(2) *Lack of uniformity in illumination.*

Strong contrasts in illumination are prejudicial to power of perception.

If the eye has become adapted to a certain brightness and must then adjust itself to a materially lower order of brightness, this results in loss of time and fatigue. If such contrasts are strong and recurrent the worker becomes gradually fatigued and his efficiency is diminished. Moreover, liability to accident is increased by uncertainty of vision. Sharp contrasts in the illumination of the workplace and adjacent surfaces should be avoided, especially in rooms where there is much traffic.

(a) *Local troubles arising from lack of uniformity of illumination.*

These may be avoided by correct choice and distribution of lamps.

Local lighting units which distribute the light widely and uniformly over the workplace are to be preferred to those giving a spot of light under the lamp.

For exterior lighting units with extensive distribution give more uniform illumination of the ground than lamps in deep reflectors. The more use that can be made (in interior lighting) of reflection from walls and ceilings, the better the chances of obtaining uniform illumination.

A surface receiving light from several sources will in general be more uniformly lighted the less the ratio between distance apart to mounting height of lamps. Lamps hung at a low level should be spaced nearer together than if hung high. In general one adopts (a) for interior lighting a distance apart of 1 to 2·5 times the height of lamps above working plane, (b) for exterior lighting a corresponding ratio of 3 to 10.

(b) *Effects of flicker.*

Flickering of light-sources should be eliminated, in the case of electric lamps, by providing constant voltage, in the case of gas lamps by constant pressure and correct adjustment. In addition, fluctuating light caused by shadows of machinery in motion should be avoided by assigning proper positions to lamps.

(3) *Light should come from the correct direction.*

Even a very high illumination may prove quite useless if the light does not come from the correct direction, e.g., if it gives rise to troublesome shadows or reflection of light from polished surfaces. It may also be that some special condition, as regards shadow or brightness, necessitated by the special nature of the work, is not fulfilled.

In the case of local lighting, one should choose, preferably, adjustable fittings which can be regulated so as to secure light falling on the workplace in a convenient way.

In general lighting, since machines and workplaces are in general so placed as to utilize the best light from the windows, one should arrange that the artificial light also comes mainly from the window side, e.g., from units placed between the windows, so that the wall in between serves as a reflecting surface. Attention should be paid to securing adequate illumination in corners of the room. In deep rooms, where several rows of lamps are necessary, the switching arrangements should be such that the row of lamps most remote from the window, where the need for artificial light first arises, can be turned on before the others.

LIGHTING SPECIFICATIONS.

For every installation a lighting specification should first be obtained from an experienced source, and only then should the lay-out of the wiring be arranged (not the reverse!). In working out specifications the following data should be furnished:—

(1) Nature of energy, current, voltage and periodicity (if a.c.).
(2) A plan of the room, with particulars of height of room, or an elevation.
(3) The nature of the ceiling, whether white or smooth; any beams, skylights, etc., should be shown in the plan. Height of beams should also be given.
(4) Colour of walls, windows, etc., shown in plan.
(5) Nature of work conducted in each room; possible positions of workplaces and machinery indicated in the plan.
(6) Cranes, transmission gearing, heating and ventilating appliances, etc., should be shown.
(7) Special requirements, whether for general or local illumination, may with advantage be indicated in the plan.

The more complete and the clearer these data the better and more expeditious will be the preparation of the specification.

The Relation between Brightness and Accuracy

As a supplement to the tests of the effect of increasing illumination on various processes, recently conducted in Germany,* attention may be drawn to a research by Professor P. W. Cobb and Mr. Frank K. Moss, summarized in the journal of the American Institute of Electrical Engineers.

There are many operations where accuracy with which a piece of work can be done is more important than speed. Accordingly the test was specially designed to test accuracy, and consisted in the subjects being asked to set a movable marker opposite a fixed one, working with several intensities of illumination, and a definite amount of time (two seconds) being allotted for each adjustment of the apparatus. The mean variation from the mean setting was taken as the criterion of precision of work. The experimental results given are the result of 25,000 individual settings obtained with ten different subjects. Four values of brightness, 1, 5, 20 and 100 micro-lamberts, were used. The *brightness* of the background is the material factor. The above values may, however, be expressed in terms of illumination by saying that they are equivalent to a range of 0·86 to 86 foot-candles on a surface having an 80 per cent. reflection factor.

The results were plotted in two curves connecting precision and brightness. For one of these the adjacent field was of the same brightness as the actual background against which the marker was viewed; for the other the adjacent field was dark. It is interesting to observe that the effect of the dark surroundings was to increase the mean variation of the settings (i.e., to diminish the precision) although the same intensities on the test object were used.

The curves are, however, broadly similar. With an increase in brightness up to 20 micro-lamberts the increase in accuracy is rapid; after that the curve bends and ultimately tends to become assymptotic.

On the whole therefore the research appears to support the view that for an illumination greater than 20-30 foot-candles the gain in accuracy, as in speed, is usually relatively small.

* *Illuminating Engineer*, April, p. 99.

POPULAR & TRADE SECTION

COMPRISING

Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers

Some Notes on Electric Lamps

No. 5

LIFE

By W. J. JONES, B.Sc., A.M.I.E.E.

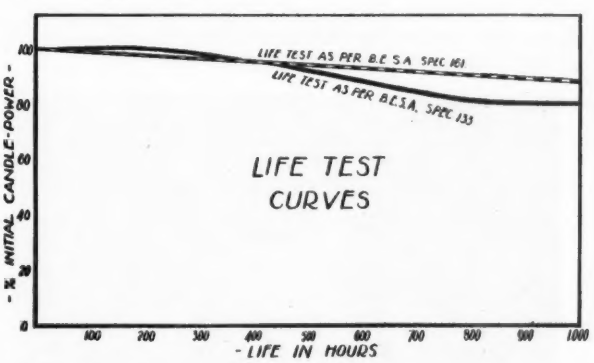
(E.L.M.A. Lighting Service Bureau).

IN the February issue of this journal a report was given of an address delivered by Mr. C. W. Sully in which he referred to the advances that had been made in recent years in the manufacture of electric lamps, and in particular to the improvement in efficiency. One of the questions which is always being asked concerns the life of an electric lamp. It is useful, therefore, to know that a committee, representing diverse interests, under the auspices of the British Engineering Standards Association, have recently specified that the average life of the electric lamp shall be 1,000 hours; that is to say, if a batch of lamps be tested and operated at their marked or rated voltage then the average life of the whole batch before burn-out will be 1,000 hours. Electric lamp manufacturers in this country have definitely adopted this specification, and the efficiency of the electric lamp has been adjusted so that the average life of normal type tungsten filament electric lamps made by them shall be 1,000 hours. This is an enormous advance, for it means that the user of electric lamps has now something definite to go upon.

It is well known that lamps of a given size and apparently identical characteristics will have very different lives when operated on different voltages, since the voltage at which they are burned determines the efficiency at which the lamps will burn. For instance, lamps operated on a voltage under that for which they are rated will have abnormally long lives, while those operated at a voltage above that for which they are marked will have shorter lives. This factor has an important bearing upon the *cost of light*, and in a subsequent article it is proposed to deal with this aspect of the economic production of light more thoroughly.

Until recently the useful life of a lamp was determined by the time which elapsed before the candle-power of the lamp dropped to a predetermined value, and this was the basis of judgment incorporated in the original B.E.S.A. specification, while the firm line represents that during life the candle-power of a lamp falls off, but as a result of recent research and improved methods of manufacture the amount of this reduction in the lighting power of a lamp with age has been considerably lessened.

The graph shows two life tests curves; the dotted line indicates the type of life test which would have been expected for lamps meeting the requirements of the old B.E.S.A. specification, while the firm line represents the kind of result which one would expect with lamps made to the requirements of the new B.E.S.A. Specification No. 161. There is a striking difference between the two curves; the old test curve indicates that during the period of 1,000 hours the candle-power fell off 20 per cent., and, moreover, that this deterioration occurred quite early in the life of the lamp. The new specification ensures that the dropping off in candle-power is very much less and that there is a considerably higher candle-power maintenance throughout the whole life of the lamp. The new specification provides, not only for the actual life of the lamp, but also for the candle-power maintenance throughout its life.



Consider the concrete case of a high-voltage 30-watt vacuum-type lamp. Under the old Specification No. 133 an efficiency of 1·65 watts per candle-power was given, with a permissible drop of 20 per cent. at the end of 1,000 hours. Specification No. 161 gives a figure of 1·50 watts per candle as the initial efficiency, and a mean efficiency of 1·62 watts per candle throughout life, which indicates a drop of only 12 per cent.. Similar improvements in efficiency and candle-power maintenance will be found it other sizes of lamps are considered.

Lighting Enterprise

THE lighting of a shop window is evidently a matter of great importance to the shopkeeper, yet it is curious how little attention has been paid in the past to this side of his business. Not that money has been stinted on lamps and fittings. Frequently, he has made a considerable outlay on these items, and yet the result is unsatisfactory. The trouble is that the light thus obtained has been misapplied. It is the old story of a square peg in a round hole. The lamps are there, but they do not do their work. This, of course, means waste—a luxury that few can afford these days.

To illustrate this point, the Bradford Corporation Electricity Department, with commendable enterprise, has arranged demonstration windows, photographs of which appear on next page. The first is lit by four naked gasfilled lamps, each resplendent in its own halo. Instead of throwing light on to the draped cloths so that these may be easily seen, they fiercely attack the eyes and almost blind them. A haze of light fills the window, making it difficult for the observer to see anything dis-

tinctly. Thus the lamps are defeating their object, for they not only fail to illuminate the wares in an adequate manner, but also irritate the potential customer by their glare so that he moves on to a window causing him less discomfort.

FIG. 1.—A bad example of window lighting.

The next picture, however, is an example of good lighting. Here the lamps are hidden, and the light is directed by means of suitable reflectors on to the objects displayed. The result is a cool, clear atmosphere, in which the exhibits may be readily seen and examined. Deep shadows are eliminated, and the whole has an altogether more attractive appearance than its fellow.

FIG. 3.—A bad example of window lighting: glare from exposed bare lamps.

Figs. 3 and 4 illustrate the same window dressed so as to display different commodities. As before, the first shows the window lighted by four bare lamps. The result is glare on the one hand and deep shadows on the other. As the goods in this case are small, the effect is even worse than in Fig. 1. Fig. 4, however, shows the improvement possible by placing the lamps in a more appropriate position. They are now out of sight, and so arranged as to produce a broad and uniform illumination throughout. The chocolates look far fresher and more enticing, while the showcards, previously enjoying a privacy of inglorious shade, now stand out boldly to advertise them.

FIG. 2.—Concealed lights: a much better arrangement.

The wisdom of the Bradford Corporation Electricity Department in thus exhibiting the difference between good and bad lighting has now been rivalled by Cardiff. During the shopping festival recently held in that city, a competition was inaugurated having regard to the best lighted shop window. Two silver cups were offered as

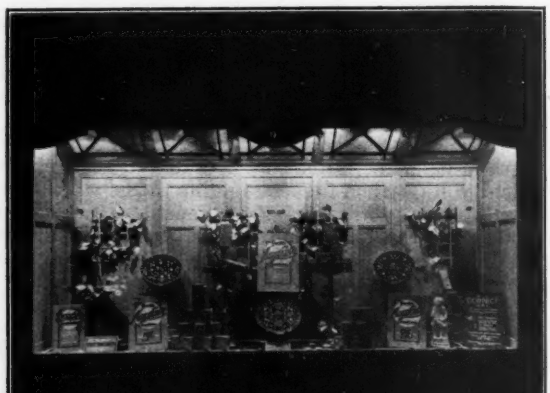


FIG. 4.—Concealed lighting from above: a much better arrangement.

FIG. 5.

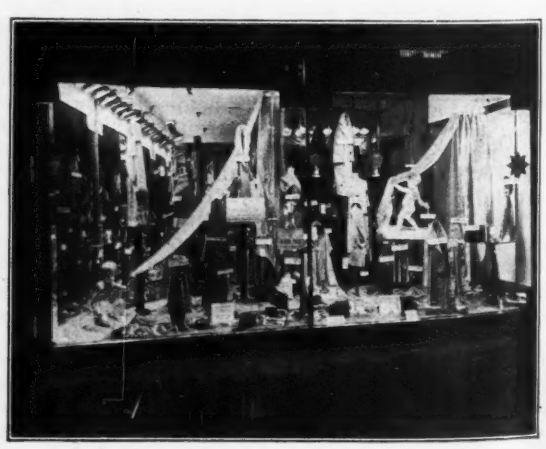


FIG. 6.

prizes—one for the centre of the city and the other for the suburbs. The first was given by the Corporation Electricity Department and the second by the Electrical Development Association. Twenty-one competitors took part, and their displays were judged by Mr. C. G. Morley New, the city electrical engineer, and Mr. W. E. Bush, manager of the E.L.M.A. Lighting Service Bureau.

Fig. 5 shows the window that was adjudged best among those in the centre of the city. It belonged to Messrs. S. Andrews & Sons, Ltd., confectioners. Although small, this window was so well lighted both as regards intensity and concealment of light sources that it stood out in a decided and arresting manner from its surroundings.

Mr. H. Collins, whose window is shown in the last illustration, was easily first among the suburban shops, and attracted much attention by his well-chosen scheme of colour lighting.

Modern Developments in Stage Lighting

IN a talk before the National Association of Supervising Electricians, Mr. H. R. Lester Groom recently recalled that it was not until the sixteenth century that completely enclosed theatres were constructed in Europe, and artificial lighting became general. He traced in detail the stages of evolution, from the original oil lamps to the introduction of the gas lighting at the Lyceum Theatre in 1803, and the much later advent of electric lighting. Remarkable effects with arc lamps were obtained by M. Leboscq in the Paris Opera House as early as 1846, but it was not until the electric incandescent lamp made its appearance that electric lighting in theatres became general; and the coming of the metal filament and gasfilled lamps has since rendered possible many effects hitherto impracticable.

As an illustration of what can be done with these modern illuminants the lecturer described the "Schwabe-Haseit" system, the main feature of which is the use of an artificial horizon. This consists of canvas painted with a special white composition, forming a smooth screen, easily rolled and unrolled by the aid of an electric motor. The whole cloth is in tension and there are no ripples or creases.

The function of the "artificial horizon" is to produce the illusion of a natural sky as a background to the stage setting. The sky effects are obtained by a battery of specially designed colour floods, the colour filter having a spread of 180° so that the whole "horizon" can be flooded with light from any individual lamp. By the blending of colours from individual lamps any desired effect can be obtained. Special colour floods in movable trolleys are placed round the bottom of the screen, so as to neutralize any lack of uniformity in illumination arising from the fact that the main battery of lamps are necessarily placed at a high level. In Fig. 1 the apparatus in use in St. Martin's Theatre, comprising horizon lamps, cloud apparatus and panorama apparatus, is shown. The cloud apparatus occupies a central position, whilst below are three panorama projectors, using 3,000-watt lamps, also shown in Fig. 2.

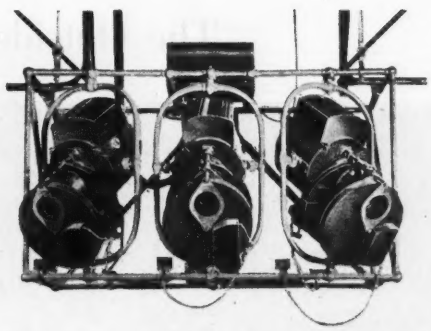


FIG. 2.—Three panorama projectors with 3,000-watt lamps; rising and falling motion.

The cloud apparatus consists of tiers of projectors which can be rotated at any desired speed, thus producing the illusion of moving clouds; the "clouds" being images of pictures on screens in the projectors. The supplementary panorama apparatus can likewise be used to project any desired images, and is capable of considerable adjustment. In particular the three panorama projectors have rising and falling motion, so as to be applied to different sections of the screen.

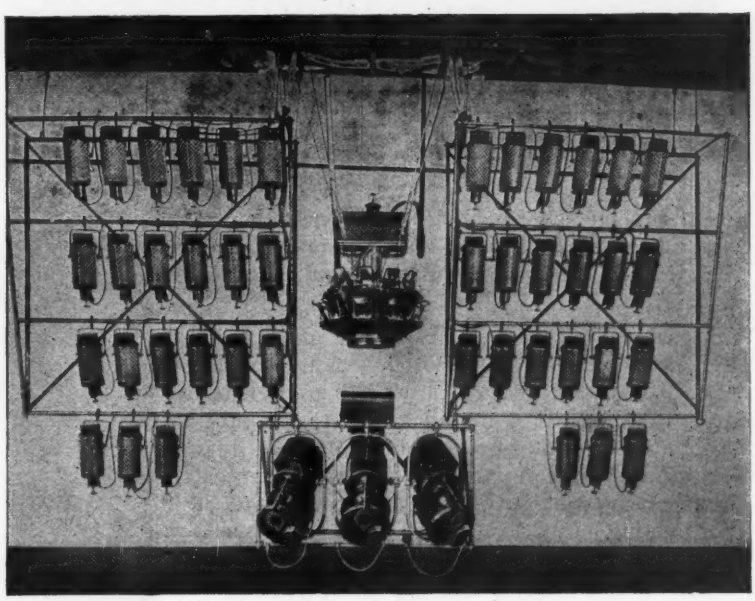


FIG. 1.—Schwabe Apparatus at St. Martin's Theatre showing Horizon Lamps, Cloud Apparatus and Panorama Apparatus.

The apparatus for the control of such units is itself highly elaborate, and there are also other special lamps, such as acting area floodlights—which flood the area occupied by actors with intense illumination—footlights, and stage projectors for producing spot-lighting effects. All these appliances utilize gasfilled lamps of varying power, and all can be fitted with colour filters enabling a wide range of hues to be obtained.

For the use of the two illustrations accompanying this note of Mr. Groom's lecture we are indebted to the General Electric Co., Ltd.

The Outside Lighting of Cinemas

The exterior of the Brixton Palladium has recently been equipped with seven powerful high-pressure gas lamps giving a light of no less than 15,000 candle-power. This well-known cinema is a bright centre of attraction at night-time on Brixton Hill.

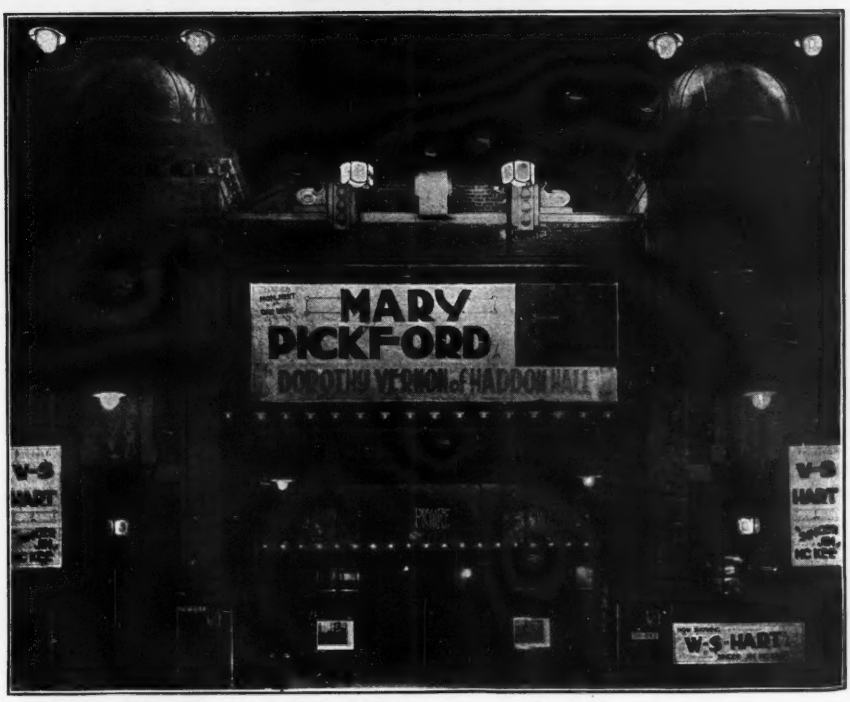
BRILLIANT exterior lighting for the cinema is considered an essential by most cinema proprietors, and it is, indeed, a most inexpensive form of advertisement.

With gas at 9d. a therm, high-pressure gas lighting will provide 1,000 candle-power for an hour at a cost for gas of only 0·9d. Superheated cluster-burner gas lamps using gas at ordinary pressure will provide 1,000 candle-power for an hour at a cost for gas of about 1·6d. It is not surprising, therefore, to find that many cinema theatres are being equipped with this economical form of exterior lighting.

A short time ago the proprietors of the Brixton Palladium, a super-cinema situated on Brixton Hill, London, carefully considered this question, and decided ultimately to use high-pressure gas. Seven lamps giving a total light of 15,000 candle-power were used for this purpose. On January 28th last the new installation was brought into operation with most satisfactory results. In this case payment for the lighting takes the form of a rental charge for the lamps, payable to the local gas undertaking. This charge includes the provision and erection of the lamps, the supply of gas to, and the lighting and extinguishing of, the lamps, and their maintenance in perfect lighting order. They are lighted and extinguished from a distance by the manipulation of control cocks placed at convenient points inside the building.

A very bright spot in South-East London. The "Golden Domes" Cinema, Denmark Hill, has its frontage illuminated by eight gas lamps giving a total of 24,000 candle-power. The lamps are lighted and extinguished from control cocks inside the building.

Exterior view of "The Palladium," Brockley, London. The seven 1,500 candle-power high-pressure gas lamps used for the outside lighting were provided and fixed by the local gas undertaking, and are supplied with gas and maintained in good lighting order at an inclusive quarterly charge for each lamp.



Eight 3,000 candle-power gas lamps illuminate the front of the "Golden Domes" Picture Theatre, High Road, Streatham, London. It will be noted that some of the light from the four lamps on the top of the building is utilized to make the domes prominent at night-time.

Gas at the British Empire Exhibition

The Lighting of the Amusements Park

THE figures as to the enormous amount of gas used at Wembley last year—40,000,000,000 British thermal units when calculated on a heat basis—are likely to be exceeded this year, as several new buffets, cafés and restaurants have been provided, in all of which gas will supply practically the whole of the heat required for catering purposes. This year, too, gas is being used for various purposes in almost every Colonial exhibit, as well as by a large number of exhibitors in the industrial and other palaces.

The Amusement Park, which was so successfully lighted last year by means of low-pressure superheated cluster-burner gas lamps, will be similarly lighted this year. This imposing and well-arranged installation consists mainly of columns fitted with two lamps, each lamp containing a cluster of sixteen small mantles. The distance across the roads in the Amusement Park is generally about 30 feet, and the lamps are spaced 60 feet apart, measured along the roads. The height of the reflectors from the ground is 14 feet 6 inches, and the light given from the two lamps on each of these columns is about 3,200 candle-power. At points where additional light is desirable, or where the lamps are so placed that their light can be seen from other parts of the Exhibition and can thus be used as an advertising force, a number of columns carrying four lamps have been installed, the observed candle-power being 6,300. That brilliant lighting played quite an important part in attracting the crowd to this section of the Exhibition last year is obvious from the fact that 96 per cent. of the visitors in the Exhibition grounds at night-time were to be found in the Amusement Park.

The Magnet Electric Home

THERE was a representative gathering of journalists at the opening of the model "all-electric" home at Magnet House, the premises of the General Electric Co., Ltd., in Kingsway, on April 30th. This is to be a permanent exhibit, which will no doubt prove very popular. Visitors, after assembling in the main hall, were taken in succession through the series of model rooms provided throughout with every form of electric domestic appliance.

FIG. 1.—The Lounge Hall.

The *lounge hall* is equipped with a central fitting in antique brass, a Jacobean table lamp and floor standard, and three two-light candle wall brackets, all giving a restful effect. Needless to say there was also an electric fire; also an electric mat to warm the feet—even a little electric pipe-lighter. Another interesting novelty was the "electric letter-box," which rings a bell immediately a letter is delivered.

The *dining room* illustrated several alternative methods of lighting. There was a central antique four-light candle fitting, supplemented by crystal candle fittings on the table. But there was also a floor-standard with crimson silk shade, enabling light to be directed downwards or emitted upwards to the ceiling, or both. Heating is again effected by an electric fire, supplemented by an "electric screen" comprising invisible heating elements—a precaution against draughts—and by an electrically heated footstool. The "Express" electric service lift, which can be operated both from the dining room and the kitchen, should also be mentioned. Let us not forget the most ingenious novelty. In the dining room at Magnet House the visitor looks out on an artificial garden—a frontage consisting of vividly green artificial grass and climbing roses, and a painted background where the artist has taken full advantage of his liberty to depict flowers in bloom to a perfection rarely attained in nature. All this is illuminated by concealed lamps, controlled from inside the room, so that the visitor can at will produce the effect of mellow moonshine or moonlight. To those fortunate enough to have a real garden this device may not appeal; but it has possibilities in city houses where there is no such outlook, and especially in restaurants and hotels in congested areas.

FIG. 2.—The Dining Room.

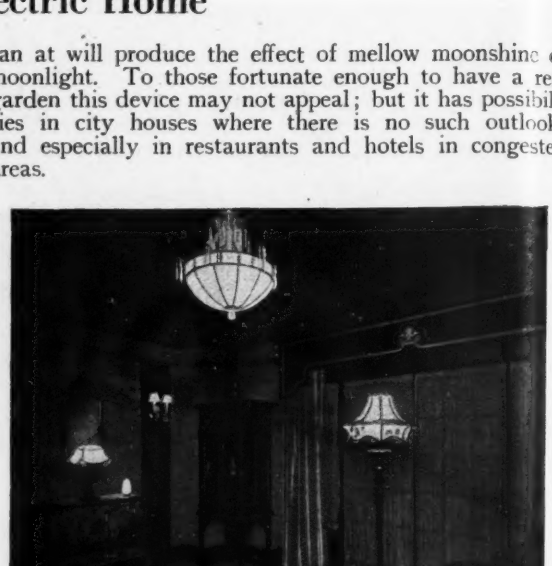


FIG. 3.—The Drawing Room.

The *drawing room* was decorated in Oriental design, with central bowl fitting and standards and bracket lights to match. Here, too, the opportunity was taken to show what electric lighting can accomplish. The window consisted of diffusing glass covered by a translucent fawn blind. Outside this gasfilled lamps are mounted, controlled from the room. On closing the switch the room appears to be flooded with sunshine, quite realistically contrived. This also is an effect which well deserves attention in hotels, restaurants and public buildings. This room is likewise provided with other electrical devices such as the "Perfuma" smoke-absorber, a decorative little table lamp, gently heating a dish which contains liquid emitting a pleasing aroma and absorbing all tobacco smoke. There is also, in an Oriental cabinet, a complete "Gecophone" wireless receiving set, with loud speaker, whence invisible wires pass to every room in the house so that wireless is "on tap" throughout.

FIG. 4.—The Bedroom.

In the *bedroom* there is ample light from a central bowl, two silk-shaded lamps over the dressing table and a table lamp at the bedside, which—like the telephone also at the bedside—is finished to harmonize with the general scheme of decoration. The bedroom, needless to say, is equipped with an electric fire, and the fortunate occupant has an electric kettle so that he or she can make the early morning cup of tea without getting out of bed. Finally, an electric fan is provided to keep the air in circulation and prevent stuffiness on hot summer nights.

The *bathroom*, *kitchen* and *scullery* are likewise completely electrically equipped. In these rooms the effective ceiling fittings furnish plenty of diffused light, and are aided by the white walls and ceiling. In the bathroom there are electric "calorifiers" yielding hot water, an electrically heated mirror and a wall plug to which a small electric shaving-water pot may be connected. Here the electric fire will be specially appreciated, and electrically heated towel rails and bathgown rails still further adduce to comfort.

In the kitchen and scullery there is again a calorifier furnishing hot water, electric washing machines, potato-peelers, dish-washers and all manner of labour-saving contrivances, whilst the kitchen is furnished with complete electric cooking implements. We were pleased to note the general use of porcelain switches, safeguarding the operator from shock, and the special device whereby all plug-contacts are rendered dead before the plug can be withdrawn. Finally we must not forget to mention the exhibit of a small electric plant, equipped with automatic generator and accumulator set.

Following the inspection of the "Magnet Electric Home," a demonstration of show-window lighting was provided, various combinations of colours from concealed lamps, the use of "spotlights," etc., being shown. Attention was drawn to the possibilities of continuing the lighting of show-windows after business hours—one of the most effective and economical forms of advertisement.

After an interval for light refreshments visitors spent some time in inspecting the very extensive G.E.C. showrooms, where a remarkable variety of lighting fittings of all kinds is on view.

Lighting Shop Windows in the Daytime

In the United States the possibility of providing exceptionally high illumination in shop windows, even during the daytime, has several times been discussed. It is argued that in general an artificially lighted window is much more effective than one which receives daylight from outside, and that during the daytime reflections in the windows of bright objects in the street are apt to be very troublesome, and materially spoil the effect of the display. The cost of providing artificial light during the daytime, especially the very high illumination then necessary, is naturally an item to be considered, but some contend that the commercial value of an effective window display is so great that in certain cases this expense is fully justified.

An inquiry has recently been made into the subject by Messrs. Ward Harrison and Walter Sturrock, and is reproduced in the Transactions of the American Illuminating Engineering Society (February, 1925). A group of observers studied 65 different windows in order to analyse the conditions on which effective window display during the daytime depends. Much depends on the kind of day. On very dark days even the order of illumination usually provided at night suffices to eliminate troublesome reflections in windows; but on a bright day this degree of illumination would be quite ineffective. Other considerations of importance are the angle at which the window is viewed, and the nature of the background to the goods. Generally speaking, a light background is more favourable to suppression of images of bright external objects than a dark one. The observers concluded, however, that in order to obtain a satisfactory effect during the daytime an illumination of not less than 150 foot-candles was required.

Public Street Lighting

In a reprinted contribution to the "Empire Municipal Year Book," Mr. J. F. Colquhoun (Public Lighting Engineer in Sheffield) draws attention to the importance of good street lighting as a means of relieving traffic congestion. Where there is any considerable traffic a minimum illumination of 0·1 foot-candle is regarded as essential. It is possible to create arterial roads by lighting, and to divert the traffic from the point of congestion by the high illumination of alternative routes, beginning possibly miles away from the danger-point. It has been shown that in industrial lighting greater speed and safety may be ensured by raising the standard of illumination, and the same applies to public lighting; It would be of great assistance if the data relating to numbers of accidents occurring by day and by night were clearly shown.

Mr. Colquhoun also suggests that every public lighting establishment should have a properly equipped testing department, where lamps and lighting appliances can be tried out. Investigations should relate to efficiency, candle-power at various angles, ease of maintenance, and durability. In this connection the author remarks that it is surprising the number of obviously inefficient lamps and burners which are still offered to those responsible for public lighting; but happily there is an increasing number of makers who put efficiency first and price second. Lights should be periodically checked *in situ* by means of portable photometers.

AN INDISPENSABLE BOOK

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ILLUMINATING ENGINEERING

By FRANCIS E. CADY,

Manager, Research Service Department, the National Lamp Works of the General Electric Co., and

HENRY B. DATES,

Dean of Electrical Engineering, Case School of Applied Science, in collaboration with nine Contributors.

486 pages, 162 figs. Size 9 x 6, Cloth, 25s. net; postage 9d.

This new book is the result of over six years' experimenting by the Staff of the Electrical Engineering Department at Case School of Applied Science in conjunction with the Research Department of the National Lamp Works of the General Electric Company, Nela Park. It is one that every engineer who has taken up, or intends to take up lighting as a vocation, will want for use as a brief, comprehensive survey of the subject and current practice. It deals with the principles underlying the production of light and its applications, rather than the details of the applications themselves, since these are subject to change due to the rapid development of this branch of engineering.

Prospectus, IL, on request.

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TRADE NOTES & ANNOUNCEMENTS

"RESTLIGHT"—A MODIFIED FORM OF ARTIFICIAL DAYLIGHT.

We had recently an opportunity of examining some forms of lighting units producing what is, in effect, a modified form of artificial daylight. Mr. F. E. Lamplough, whose name is associated with the special daylight glass developed for accurate colour-matching has evolved a screen known as the "Lamplough Restlight Glass," which has the property of smoothing out a great deal of the excess of red in artificial lights, and thus producing an illumination which is claimed to be extremely restful and pleasant in use. In appearance the glass somewhat resembles the daylight glass in a less highly coloured form; whilst it renders the light distinctly "whiter" it is not intended to reveal colours very accurately, and we understand that the absorption of light is not more than about 50 per cent.

The effect resembles mild diffused sunlight, and it is believed that they will prove useful in picture galleries, studios, art schools and other places where the extreme accuracy of precision daylight is not required. Similarly, the Lamplough Restlight is recommended for use in schools, offices, banks, public libraries and other places where occupants use their eyes somewhat closely. It occurs to us that such units may also have a useful function in bridging over the period when daylight is failing and it becomes necessary to use artificial illuminants. The difference in colour is always a difficulty when the two illuminants are mixed. The use of artificial daylight helps to obviate the difficulty, but the loss of light in such units is inevitably high. Hence the "Restlight," with its comparatively high efficiency and general similarity to daylight, should prove useful.

METRO-VICK SUPPLIES, LTD.

The new catalogue issued by Metro-Vick Supplies, Ltd., dealing with electrical supplies contains practically everything electrical from a supply point of view, and most of the articles listed are of the firm's own manufacture. The catalogue is on the loose-leaf principle—a modern method which enables additional sheets issued from time to time to be incorporated.

We mean to refer to this and other publications of the Company more fully in our next issue.

PHILIPS LAMPS, LTD.

From Philips Lamps, Ltd., we receive a copy of the latest leaflet giving particulars of all standard modern types, amongst which special interest attaches to the "Argenta" (opal) type, which are made by a special process giving minimum absorption of light. Of special types sign, traction candle and tubular types are included, and we observe that the firm also supplies the neon gasfilled lamps, consuming only 5 watts on any d.c. or a.c. circuit and especially useful fon night lights, etc.

We are also interested to observe that, in order to be able to serve North-East and North-West England in the shortest possible time, the company has opened branch offices at Manchester and Newcastle. The address of the Manchester branch is: Philips Lamps, Ltd. (Manchester Branch), King Street West, 2 and 3, Lofthouse Court, Manchester; and of the Newcastle branch, Philips Lamps, Ltd. (Newcastle-on-Tyne Branch), 30, Handyside Arcade, Percy Street, Newcastle-on-Tyne.

B.T.H. VALVES.

A leaflet issued by the British Thomson-Houston Co., Ltd., announces important reductions in the price of all B.T.H. valves. We understand that a new leaflet relating to these valves is in preparation, and a supply will be obtainable from the Publication Department of the Company at Rugby.

CONTRACT FILLED.

The following contract is announced:—

MESSRS. SIEMENS and ENGLISH ELECTRIC LAMP CO., LTD.: *Corporation of Kingston-upon-Hull*, tender accepted for the supply of traction type lamps and gasfilled lamps for twelve months.

SIEMENS SPECIALITIES.

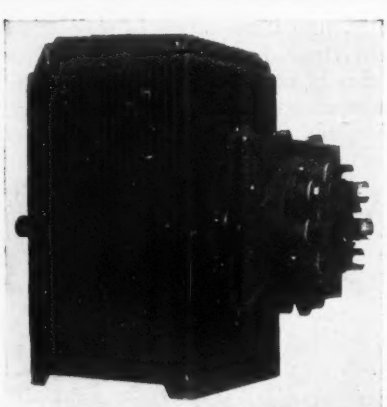
Two current lists received from Messrs. Siemens and English Electric Lamp Co., Ltd., deal respectively with "Silvaray" one-piece glassware fittings and Zed fuses. The Silvaray units are made in an attractive series of types, and they should be useful in meeting the demand which now exists for well-constructed enclosed lighting units which are practically dust-proof. Attention is drawn to the specially manufactured glassware, in which a special effort has been made to combine good diffusion and minimum absorption of light.

In the Zed leaflet full details are given of these fuses, and there is a series of useful curves showing the characteristic curves for cartridges for 250, 500 and 750 v.

PUBLIC LIGHTING BY GAS.

We have received an illustrated booklet summarizing a lecture recently delivered at the Technical College, Huddersfield, on the above subject by Mr. J. W. Lofts, and published by Messrs. Wm. Sugg & Co., Ltd.

The lecture contains some interesting reminscences of pioneering developments in gas lighting, and pictures showing forms of fittings originated as early as 1878 are reproduced. The book also contains a comprehensive series of night photographs of public lighting in various cities, polar curves of many forms of Sugg lighting units, and a useful table giving figures for illumination derived from typical modern cluster units spaced in various ways. Altogether it is an enterprising and complete publication which should be useful to the many local authorities, etc., who handle Sugg lamps.



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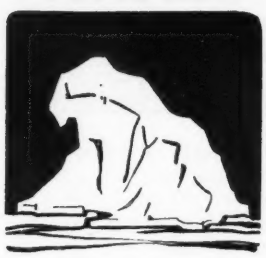

inert but effective

THE gas in the bulb of a gasfilled electric lamp is entirely inert and inactive. It doesn't burn. It can't escape. It doesn't combine chemically with the filament.

But it isn't useless. It is the very inertness of the gas which make possible the high efficiency of the gasfilled lamp, because it enables the filament to be operated at a much higher temperature than the filament of an ordinary tungsten lamp, without chemical change or other detrimental result.

The master patent governing the manufacture of *all* gasfilled lamps is a Mazda patent. By using Mazda Lamps you make sure of obtaining as much light as it is possible to produce for a given expenditure on current and lamp renewals.

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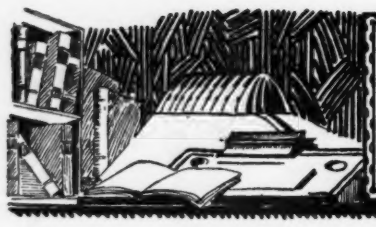

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

ILLUMINATING ENGINEERING: FOR STUDENTS AND ENGINEERS. *Edited by F. E. Cady and H. B. Dates. (Chapman and Hall, London,* 1925, 486 *pp.*, 162 *figs.*, 25/- *net.)*

In the preface to this work it is recalled that a course in illuminating engineering was established at the Case School of Applied Science in 1918. The contents of the book are based on six years' experience of this course. It may be recalled that other special series of lectures have been arranged in the United States, notably those at the Johns Hopkins University, Baltimore, in 1915, and these lectures were afterwards reprinted. The present work, however, in summarizing data presented in a regular course that has now been in existence for six years, approaches more nearly to the conception of a textbook on illuminating engineering.

In view of the series of lectures now being given at the Polytechnic (Regent Street, London), which it is hoped will be the forerunner of a permanent course, this book is of considerable interest. For some time the need for a textbook on illuminating engineering has been felt in this country. An introduction by Dr. E. P. Hyde explains the part taken by the two editors in collecting the information. Many of the sections are by experts on the particular subjects treated.

The introductory chapters include elementary information on the nature of light, and the laws of radiation underlying light-production. The theory is up-to-date. We have also the familiar diagrams illustrating distribution of energy in the spectra of various illuminants, and the relation between energy-distribution and temperature of an incandescent black body. According to a table of luminous efficiencies the 1,000-watt gasfilled lamp has about one-fifth of the efficiency credited to the sun; whereas a black body operating at 6,500° K. has 90 per cent. of the efficiency of solar radiation.

A section by Mr. H. Lyon deals with combustion and the theory of the Bunsen burner. This is useful information for students, but we miss any detailed account of the latest forms of incandescent gas lamps, and figures for their efficiency, comparable with those given later for electric lamps, seem to be lacking. Arc lamps and electric incandescent lamps are very fully treated; there is also some account of electric illuminants of the vapour tube type, and such curiosities as the light of the firefly and living photogenic organisms.

Mr. F. E. Cady's treatment of photometry and Mr. Luckiesh's handling of colour are both good, and the subsequent sections of shades and reflectors, calculations and planning lighting installations, etc., whilst following familiar lines, contain information that a student ought to know. The tables of foot-candles values and utilization coefficients are likewise useful, though the student should realize that they only form a groundwork, and that many problems can only be solved by special methods. The chapters on industrial lighting, sign and display lighting and flood-lighting contain much condensed information, and the final section on projection of light contains an excellent survey of this new field. The subject of daylight illumination is dealt with, though we think that here the editors might with advantage concentrate matter appearing in different sections and add a little more definite information on methods of calculation, including a definition of the "daylight-factor," which forms the basis of scientific study of access of light into buildings.

Whilst there are a few points to criticize there is no doubt that the book as a whole contains a review of illuminating engineering that should be extremely useful to students. Much of the information is exceptionally up-to-date and of a kind not readily accessible to students. In view of the admitted difficulty of correlating contributions by different authors there is little overlapping. References to literature are given at the end of each chapter, and there is an adequate index. The illustrations are well executed and the paper and printing and general get-up quite satisfactory.

SCHOOL VISION AND THE MYOPIC SCHOLAR, *by James Kerr, M.A., M.D., D.P.H. (Geo. Allen and Unwin, Ltd.,* 1925, 159 *pp.*, 5/- *net.)*

This little work is stated to be intended for teachers and school workers, but it makes easy reading for anyone who wishes to know something of conditions affecting the eyesight of school children. Dr. James Kerr is well known to our readers as a member of the Council of the Illuminating Engineering Society, and we are glad to note that he has included a section on hygienic lighting. The first chapter deals with common diseases of the eye, and we then pass on to a discussion of "the process of seeing." This leads to the treatment of myopia and a diagram, showing the percentage of myopic children found in Govan is reproduced. The curve is a striking one and shows how the percentage tends to increase during school life, attaining 25 per cent. at the ages of 17 and 18. The treatment of subnormal vision cases is taken up in considerable detail, and there is an illustrated chapter on the teaching of reading, writing and drawing. Dr. Kerr lays it down as an axiom that in schools for myopes no eyework, blackboard or otherwise, should be done by artificial light—a confession that the artificial lighting of our schools is far from perfect as yet. The book, as is proper, is printed on mat paper in good type and illustrated by many clear and useful sketches. The printing and general get-up are good, though we notice some imperfections on p. 107, where, as it happens, the author is emphasizing the necessity of clear type.

A CENTURY OF GAS IN SOUTH LONDON *(South Metropolitan Gas Co.,* 1924, 23 *pp.*, 15 *plates).*

Under the above title the South Metropolitan Gas Co. has issued a very pleasing book which contains a most readable account of the history of the Company. After various early experiences the first gas works on the south bank of the river was constructed by Munro, an enterprising Scot, in 1814, and this was sold to the South London Gas Co., soon merged in the Phœnix Gaslight and Coke Co. This concern, after many vicissitudes, ultimately was taken over by the South Metropolitan Gas Co. The description of the struggles of these early companies and their amalgamation reads like a romance.

In the account of the Company's development a prominent position is naturally assigned to the late Sir Geo. Livesey's great scheme of copartnership. There is a well written description of the processes of modern gas manufacture, and of the Company's vast works at Greenwich, which form the subject of an impressive sketch. The book is illustrated by many charming pencil sketches, whilst in an appendix there is a series of portraits of officials who have occupied important positions in the history of the Company, terminating with Dr. Charles Carpenter and Mr. Frank Harding Jones.

LONDON ELECTRICAL ENGINEERS.

27th (London) A.A. Battalion R.E. (T.A.),

(46, Regency Street, Westminster, S.W.1.)

JUNE, 1925.

Honorary Colonel: Col. R. E. B. Crompton, C.B., M.I.Mech.E., M.I.E.E.

Officer Commanding: Lieut.-Col. C. H. S. Evans, O.B.E., A.M.I.Mech.E., A.M.I.E.E.

The following orders have been issued for June:—

304th Company (Major W. H. Merrett, T.D., A.M.I.E.E.), Mondays 7 p.m. to 9-30 p.m. H.Q., Royal School of Mines and Hyde Park.

305th Company (Major A. W. M. Mawby, O.B.E., A.M.I.E.E.), Tuesdays 7 p.m. to 9-30 p.m. H.Q., Royal School of Mines and one Mobile Station.

306th Company (Major F. C. Clarke, A.M.I.E.E.), Fridays 7 p.m. to 9-30 p.m. H.Q., Hyde Park and Royal School of Mines; 2 officers and detachment for 12 lights at Wembley throughout the month.

Lorry Drivers Week-end Camp (304th Company), Whitstable during the month.

Headquarters is open till 8 p.m. on weekdays and 1 p.m. on Saturdays.

THE RELATION BETWEEN HIGHER ILLUMINATION AND EFFICIENCY.

Sir,—The series of tests on the above subject, recently made in Germany and summarized in your April issue (p. 99), seem to confirm in the main modern views of the advantages of higher illuminations, and are particularly useful in giving some indication of the limits to which such increases can advantageously be pushed. The attempt to devise processes involving different mental and manual processes is interesting.

One would like to see similar experiments undertaken in this country, and the matter may be commended to the Committee on Illumination operating under the Department for Scientific and Industrial Research. Data have been furnished from time to time illustrating the advantages of better lighting in actual industrial operations; such data are valuable but extremely difficult to obtain with accuracy. Lengthy experiments almost inevitably necessitate some interference with the routine of work; and any psychologist will agree how difficult it is to eliminate the personal element, and to prevent results being affected by mental impressions of the employer and worker.

There is, therefore, something to be said for laboratory experiments free from these complications. Such tests also enable one to separate out different processes and qualities (e.g., speed of perception, acuteness of vision, mental concentration, etc.) to an extent difficult in an actual factory. Such experiments should, if possible, be supplemented by actual tests of specific industrial and clerical occupations.

One thing, I think, is now generally admitted. Tests of this kind must be undertaken by an entirely impartial and recognized authority, in order to carry sufficient weight. This has recently been recognized in America by the decision that experiments on the advantages of better lighting should be undertaken by the National Research Council. In this country the committee working under the Department for Scientific and Industrial Research, which is in close touch with the Illuminating Engineering Society, the National Physical Laboratory, and other scientific bodies, seems to be in a specially favourable condition to undertake such tests.—Yours etc., INVESTIGATOR.

ADVANCES IN ELECTRIC MINING LAMPS.

Dear Sir,—In your March issue you print on p. 60 an interesting note on advances in electrical mining lamps, and you raise the important question of the *quality* of the bulbs used. The advice you give is timely and valuable. Immediately after the war the quality of the bulbs varied greatly, and a difference of 40 per cent. in the illumination might be given by two varieties. I have not seen a colliery equipped with the miniature lamps described in your note, but agree with you that such an installation would be false economy.

Lighting equipment is "primary" machinery requiring skilled attendance, and only the best lamp procurable is good and cheap enough to install. I have suggested elsewhere that all lamps should be checked periodically with a single grease spot against a standard lamp; it is not necessary then to take actual candle-power readings. The use of lamps weighing ten pounds offers considerable drawbacks, and the increased illumination given by these lamps may be obtained more easily with a cap lamp.

Quite apart from miners' nystagmus adequate illumination in the coal mine is necessary for the economic production of coal. —I am, sir, Yours faithfully, T. LISTER LLEWELLYN.

[We are very glad to have Dr. Llewellyn's endorsement of the need for lamps of good quality and the primary importance of better lighting in mines. The economic advantage to which he refers was illustrated in the research conducted by Messrs. E. Farmer, S. Adams and A. Stephenson for the National Institute of Industrial Psychology in 1922. This led the investigators to conclude that even a lamp five times as heavy as the ordinary miner's lamp would be acceptable, in view of the much higher illumination secured. But the problem, whether this necessary higher illumination is to be obtained by using a bigger battery and more powerful lamp, or the "cap-lamp," or by a combination of both methods, can best be solved by co-operation between medical and lighting experts and practical colliery engineers.—ED.]

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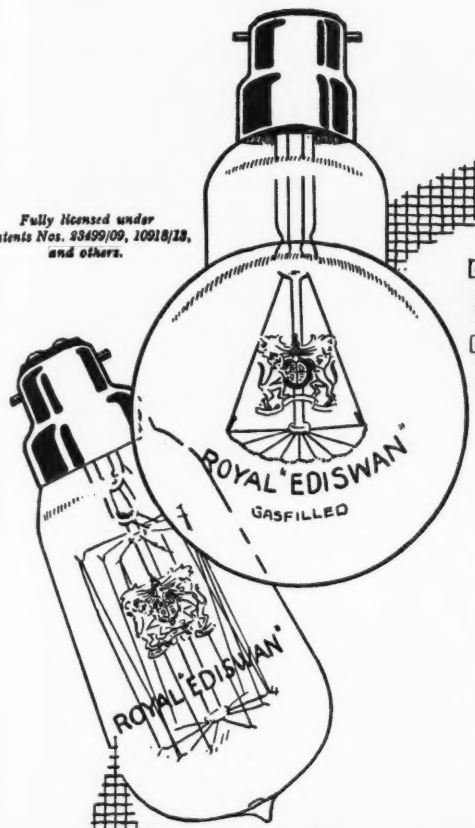

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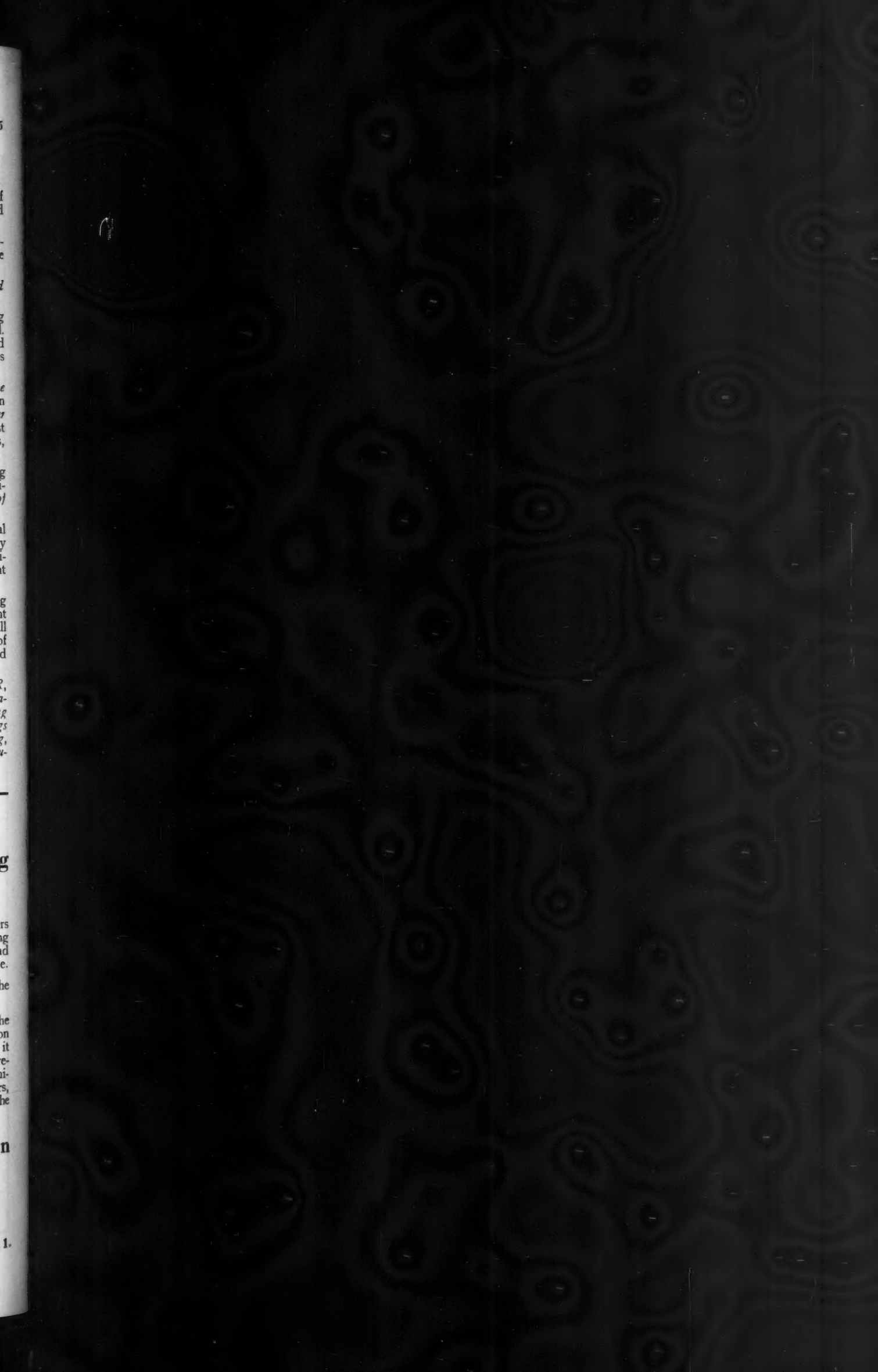
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